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Some Senatorial Views on the Panama Canal.

The views on the type of canal for the Isthmus of Panama of four members of the U. S. Senate Committee on Inter-oceanic Canals have been expressed in a minority report of that committee, published since the preceding issue of this journal. It is a legislative document of remarkable character. Its general tone impresses one on its first reading as expressing almost frenzied fear lest the sea-level plan be adopted. It is in striking contrast to the judicial character of the committee report. The exaggerations of statements of facts are often so excessive that they become actual misrepresentations, while other portions of

the statement are not free from undignified and needless personalities. The fact that Messrs. Hunter and Burr, of the Advisory Board, have recognized the results of the greatly extended investigations of late years and the far greater development of plant and methods for executing canal work on the Isthmus, and hence now fully indorse the sea-level plan, whereas years ago, when but comparatively little was known of the actual Isthmian conditions and all the circumstances were radically different from those now existing they favored lock plans, seems to be an offense to the friends of the latter plans not to be forgiven easily. The minority of the Senate Committee appears to be of the opinion that there can be no development or evolution of mature judgment based upon completed knowledge, extension of data and a much clearer view of the capacity of modern construction plants suitably adapted to the Isthmian Canal project. Moreover the manner of presentation of the minority report so savors of press-agent methods of publicity, in which the basic facts are buried beneath trivial details, to which excessive importance is attached, that the reader who has studied canal subjects is disgusted.

The attitude of the minority toward the physical facts disclosed by the investigations on the Isthmus and their bearing upon the necessary works is illustrated by their treatment of the question of percolation through the subsurface material at the proposed Gatun dam site. The report states that the "rock sometimes called indurated clay . . . comes within twenty or thirty feet of the surface at every part of the dam, except at two places . . ." Immediately following is the statement, "At the narrow bottom of each depression . . . however, some 200 feet down, is sand and gravel, porous and water-bearing." It would be difficult to write a more grotesque distortion of the actual facts. At the location considered, there are two deep geological valleys filled with porous materials shown by the borings to be freely water-bearing at practically all depths greater than thirty-two feet below the surface. There are a number of other statements of a similar character regarding important physical features of the situation, but this instance suffices for illustration.

The dangers of the flight of three locks at Gatun to be incurred by every ship passing them are belittled by arguments the fallacies of which have been conclusively shown. In this connection the provision of a double set of guard gates at the highest level is cited, without stating, however, what was clearly brought out in the examination before the committee, that their use is not contemplated for such great ships as those now being built for the Cunard Line; in other words, for the very ships most needing them. Nor is it further stated that the locks proposed are not large enough to receive those great ships should the guard gates be employed, nor is there water enough over the miter sills to pass them. These excessive exaggerations or misstatements in favor of the lock plan are well supplemented by similar observations in criticism of the sea-level plan. Not satisfied with the actual extreme range of tide in Panama Bay of twenty-one feet, an extreme range of twenty-three feet is named, involving an error of two feet. That part of the minority statement, or misstatement, relating to currents in the sea-level canal, including cross currents which can never exist, is so evidently prejudiced that it can be allowed to take care of itself. The direct currents due to floods can never be as large as stated and those which can exist in the greatest floods, for a few hours only, would, according to the record, occur on an average but once in about ten years.

At one place in the minority report of the Senate Committee it is stated that Mr. Hunter "in effect concedes that the (Gatun) dam will be

stable," but in his letter to Senator Kittredge he writes, "a further experiment in engineering construction and one of an almost equally hazardous character (i. e., as the three locks in series at Gatun) is offered in the design of the earth dams at Gatun . . . and at La Boca and at Corozal . . ." At another place in his letter, referring to the proposed Gatun dam, he calls it "a mere mound of earth provided with neither core wall nor cut-off, . . . but which is assumed from the results of a few borings to be sufficient for the tremendous purpose which the dam is desired to serve. The danger to be apprehended is that of subterranean erosion. . . ." This misstatement of the minority is equivalent to an untruth and there are others of the same character which it is unnecessary to quote.

In discussing the question of malicious mischief, the minority report states that "the Culebra cut in some places" is "more than 600 ft. deep." This wording as it stands is not a statement of fact. It is not true that the Culebra cut is 600 ft. deep in the sea-level plan at any point. The idea that the slopes of this cut could be surreptitiously mined and blown into the canal prism by a malicious enemy is obviously absurd.

The criticism of the estimated cost of the sea-level canal based upon the claim that the unit price for the excavation of the canal prism in the Culebra cut should have been taken at \$2.50 per cubic yard, instead of half that amount, is difficult to understand, unless, indeed, it is accounted for by Mr. Stevens' statement before the Senate Committee that he was unable to state any method of doing that part of the work!

It is a waste of time, however, to pursue at length the consideration of the details of this extraordinary report. As groundless as are the greater part of the criticisms of the sea-level plan, its fatal weakness really lies in what it fails to answer. It takes no note of the days of delay to the passage of shipping through the proposed lock canal, which would be incurred by some of the vessels arriving in fleets; the delays to which a fleet of naval vessels would be subjected in attempting to pass the lock canal, and which might imperil great national interests in time of war; nor the fact that the actual capacity of the proposed lock canal has been shown not to exceed half that claimed for it, with a possibility of its being much less. The report ignores other physical features of the proposed lock plan, which would increase the time of passage, enhance the dangers to vessels using it, and swell both its cost and the time required for construction.

One important matter has escaped the notice of the minority of the Senate Committee, to which attention was called in the issue of THE ENGINEERING RECORD of a week ago. The chairman of the Isthmian Canal Commission is responsible for the statement that the chief engineer expects not later than August of this year, the midst of the rainy season, to have forty steam shovels excavating material in the Culebra cut, including both hard and soft rock, at the rate of 12,000,000 cu. yd. per year. Hence with eighty steam shovels, his rate of excavation when that number are installed will reach 24,000,000 cu. yd. per year, without allowing for any advantage accruing to the work during the dry season. Furthermore, the cost of this excavation has already dropped to 53½ cents per cubic yard, and manifestly it should fall sensibly lower with completed organization and the installation of the full plant. Obviously, therefore, the 110,000,000 cu. yd. of excavation required at the Culebra cut by the sea-level plan can certainly be completed within nine to ten years, as shown by the careful estimates of the consulting board. As the minority of that board estimated that the building of the great works of art of the lock plan, including the locks and dams, would require practically the same length of time, it becomes highly probable that the execution of

the sea-level plan can be completed in sensibly the same period of time that was assigned for the lock plan, and that the cost of the latter is likely to approach much more nearly that of the former than even the advocates of the sea-level plan have supposed.

The Beauty of Cities.

It is gratifying to those who believe that measures should be taken to improve the appearance of American cities, to note the widespread attention to this subject which is evident throughout the country. The appearance of the cities of Europe is, as a rule, far more attractive than that on this side of the Atlantic, mainly because the buildings there are of more substantial construction and designed with regard to their effect in connection with adjacent structures rather than to obtain striking individuality. Many of the old cities have narrow, winding streets which render the architect's problem a difficult one, but in the new portions of the cities, where straight streets are laid out, the restful and harmonious character of buildings and their surroundings is the result of an artistic development that should be encouraged in the United States.

The main feature of the problem for us is to plan for the future as well as the present. We have to spend so much money in all kinds of construction, streets, water works, sewerage systems, public buildings, schools, police, fire protection, the care of the insane and in other directions, that costly monumental work must necessarily come slowly. The fact that we have little of it is not an indication that we do not desire it, but rather a sign that until the real necessities of our municipal growth and administration are satisfied we must lay aside the problems of civic art. That we do not underestimate the importance of aesthetic considerations in our municipal undertakings is apparent to anybody who keeps in touch with sentiment in different parts of the country. While comparatively little is being done on account of limited funds to rectify the mistakes of the past or to minimize them by the construction of monumental structures, the municipal problems that must be solved now are everywhere being considered with a view to the future as well as the present. While not enough time and study can always be given to them, the intention is admirable and gratifying. Two instances of it, from the opposite shores of the continent, afford typical examples of this spirit.

One of the most creditable features of New York is the Riverside Drive, skirting the Hudson River. It is a magnificent boulevard, used by rich and poor alike. It can be extended northward so as to serve as a place of recreation for many people living in the northern end of Manhattan Island; in fact, such an extension is logically demanded by the growth of the population of the borough and by the topography of the island. At the present time the property for this extension can be purchased at a comparatively low figure, and accordingly the Board of Estimate and Apportionment has instructed the Borough President to prepare plans for this work, running from the present terminus of the Drive at 158th St. to a connection with the Henry Hudson Memorial Bridge. The roadway and its structures have been estimated by Mr. Nelson P. Lewis, chief engineer of the Board, to cost about \$2,225,000, a viaduct across the Dyckman St. valley will cost about \$2,000,000, and other necessary works will bring the expense of the undertaking up to about \$5,250,000. The work is the logical development of conditions which will not be apparent except

to the trained municipal official for some years; if it is undertaken now, it will be far less expensive than if put through ten years hence and, moreover, it is now possible to plan all parts of it as they should be instead of fudging some of them to conform with conditions which may arise later. The construction of the boulevard will add enormously to the value of property in the region traversed and will establish the character of the buildings to be erected along its route, which is desirable for several reasons. The proposition is an excellent instance of the purpose of American city officials to plan for the future.

Another example of quickness to take advantage of opportunities for civic betterment is afforded by the discussion of the plans for the improvement of the street system of San Francisco made by Mr. D. H. Burnham. San Francisco, like the immortal Topsy, just grew. Whatever beauty the city possessed was a matter of good luck; her many hideous features were no offense to her citizens on account of their long familiarity with them. Although the topography of the city presented exceptional opportunities for an admirable street plan, affording superb vistas and exceptional locations for impressive public and private buildings, not the slightest attempt had been made to utilize these natural advantages. In fact, not even the mere necessities of civic existence were regarded in the street plan, and the fire risk was greatly increased by the presence of streets with very steep grades and by the narrow width of many of the carriageways in the older districts. The parts of the city where these conditions were worst are now in ruins, and it is proposed to reconstruct them so that a city beautiful as well as a city useful shall result. This does not mean that wood, the natural building material of the city, shall not be used as before, but that the city shall have a street plan which will be as useful to the San Francisco of 2006 as of 1906, which will encourage the construction of handsome buildings and at the same time diminish the fire risk by affording wide, open lanes across which the flames of a great conflagration cannot leap. The opportunity to reform the street plan and to improve the fire-resistance of the city is thus a single problem, and the Burnham plans and the consideration they are now receiving are collectively another instructive example of the growing appreciation of the importance of municipal appearances.

Impermeable Embankments.

The Hope reservoir of the Providence, R. I., water-works has recently afforded an instructive lesson in one feature of dam construction. This reservoir is formed by an earth embankment paved on the inner face. It is about thirty years old and has had a slight leak from the time it was put in service. From time to time public attention became fixed on this leak and a mild scare occurred, which was quickly abated by the refusal of the public authorities to show the slightest feeling, other than humorous comments, concerning the matter. The basin was recently drained for the purpose of cleaning it, and a search was made for the leak. The inner lining appeared as tight as when first put in place. Finally some of the red coloring substance used in making strawberry ice cream was dissolved in a quantity of water and this colored liquid was pumped into the opening in the outer slope through which the water emerged. In a short time the liquid appeared at the foot of the inner slope and the hole was thus located. It was apparently about 100 ft. long and will probably be repaired by pumping grout into it and by recon-

structing a portion of the inner slope pavement.

The incident is interesting because it shows that it is not always safe to rely on the sediment in water to stop slight percolation, as is often done. The water that enters this reservoir is remarkably free from suspended matter, and the original seam was not silted up, but became larger. This fact is also instructive, for it is often asserted that a stream of water an inch or more in size will quickly wear away an embankment, yet the Hope reservoir had been penetrated for some time by such a stream without apparent injury. Occasional attempts have been made to stop the leakage by forcing clay or cement into the hole, but without much success, which is an indication of the quantity of water that came through the passage.

This incident is not advanced as an argument that a leak of 100,000 gal. daily in the side of an earth dam is to be disregarded, nor as a precedent for omitting precautions to make such an embankment perfectly tight. The lesson to be drawn is that a first-class earth dam can resist the attrition of a considerable stream of water provided the latter does not have too great velocity. In this Providence reservoir the hole grew larger very slowly and unquestionably might have caused trouble if it had been allowed to develop indefinitely; in fact most engineers will probably agree that it should have been stopped before, even at some inconvenience to the water consumers. Nevertheless the incident discloses the value of good workmanship in building earth dams. This basin had puddled embankments built in the days when the manufacture of puddled filling was not only understood but was required. At the present day it is a lost art except with a comparatively few engineers, and reliance is placed on concrete for water-tightness. As a matter of fact, puddled earth of the right quality and properly prepared is rather expensive, and it is entirely possible that conditions may arise which will make concrete preferable as a protection against percolation. In many cases, however, good puddle well protected from direct action of the water is the best material to use in securing an impervious embankment. It requires a great deal of manipulation, as will be evident from the specifications for the puddle on the settling basins of the Columbus water purification works, printed in this journal on February 24 of this year, and the hole that has existed in the Hope reservoir for thirty years shows that even in the best of work a little relaxation of attention may result in a defect. The excellence of the material when properly prepared and placed is such, however, that the money and time spent in securing it are justified in most cases.

The subject is deserving of considerable attention because there seems to be a tendency at the present time to rely on concrete cores and on rolled earth of any nature for tightness in dams of ordinary cross-section. A masonry core wall has been a feature of earth dam construction which this journal has long advocated, although it is contrary to the practice of most British engineers. It has not attempted to defend this core on the ground that it is a material aid in securing a tight dam, however, for the investigation made by Messrs. Croes, Smith and Sweet five years ago showed that the occasional claims on that ground were unwarranted. The tightness of the dam should be due to the earth itself, and this can only be obtained by making the dam very wide at the base, much wider than is usually practicable for other reasons, or by paying careful attention to the selection, mixing and placing of the materials. Failure to follow these principles resulted in the notable reservoir troubles in Brooklyn and Philadelphia, and many less important instances, and those examples, when compared with the long-continued leakage at the well-

built Hope reservoir, furnish an excellent illustration of the advisability of calling for and insisting on thoroughly good construction in earth dams of the usual cross-sections.

Government Press Bureaus.

Many of the readers of The Engineering Record will recall the stir that followed the publication of Dr. Moritz Busch's "Bismarck," in which some of the methods of the Iron Chancellor were laid bare. One of his sayings was: "One learns more from the newspapers than from official despatches, as, of course, governments use the press in order frequently to say more clearly what they really mean." In accordance with this view, Bismarck engaged Dr. Busch "to write notes and articles for the papers from such particulars and instructions as I (Bismarck) may give you, for, of course, I cannot myself write leaders. You will also arrange for others doing so. I must have some one especially for this purpose, and not merely occasional assistance as at present, especially as I also receive very little useful help from the Literary Bureau." The two volumes of this famous biography were a revelation to most readers concerning the manufacture of public opinion through the press, and the details of the German publicity methods were so well worked out that they will always remain deserving of attention. It now appears, however, that in some respects, we have so far excelled the publicity details of the old days of the German empire, that it is no longer necessary for us to think at all on any subject of national importance.

In the quarter century that The Engineering Record has been endeavoring to reflect the views of those men who make civil engineering a profession rather than a handicraft, there has never before been such a rampant attempt to furnish Congress and the people of the country with ready-made opinions on everything under the sun. When the thing began, it was looked upon merely as an affair of the moment, a plaything that would be discarded soon; but this expectation has been disappointed, and the editor who now attempts to state the actual condition of public opinion and to express views in defiance of those manufactured for him by the national publicity bureaus, is in danger of some Americanized law of leze majesty. This would not be a matter to be discussed here were it not for the attempt to control from Washington public opinion on technical subjects. We have seen great industries attacked unfairly on the strength of reports which were sensationally written and so incorrect as to be ludicrous to those who know the facts. We have witnessed the amusing attempts of these press agents to follow the erratic wanderings of their inspiring genius, and have laughed at the manner in which they were forced one day to eat the words they put forth as wonderful revelations a fortnight or a month before, and we are now seeing an inexplicable attempt to spread abroad through the newspapers statements concerning the Panama Canal that have little or no basis in fact. As one by one the claims made by former advocates of a high-level canal are demolished by the data accumulated at the Isthmus by Mr. Stevens and in other ways, new points of support for that enterprise have to be hunted up, until the affair, as handled from Washington, has ceased to be a rational discussion of an important public engineering problem and has degenerated into a childish game of hide-and-seek. As the subject now stands, the opinion of the majority of engineers is that a sea-level canal should be constructed, not only because it is the best type for its purpose, but also because its construction will be far less expensive and time-consuming than has been

asserted by former advocates of a high-level canal. The frantic endeavor to mould public opinion to a contrary view through the press is not the kind of proceeding that arouses confidence. The people of the United States expect the government to build the best type of canal, the sea-level type, and the prolonged attempt to go contrary to engineering advice and to back and fill until, by some hitherto undiscovered means, justification for the high-level type can be found, is undignified jockeying with a serious subject. The people of the United States can do their own thinking and are not misled by erroneous assertions in Washington dispatches of what they believe.

Notes and Comments.

FLAKE GRAPHITE LUBRICATION has been tested by Prof. Goss at Purdue University in comparison with neat kerosene lubrication. For this purpose one part by weight of Dixon's flake graphite was mixed with two parts of kerosene. The immediate effect of adding the graphite was to permit an increase of load from 50 to 110 lbs. per square inch, and to reduce the coefficient of friction from 0.00547 to 0.00296. Another result was the excellent running of the bearing with kerosene alone after the rubbing surfaces had been cleaned; this was due probably to the enduring effect of the graphite in the microscopic pores of the metal.

LOCOMOTIVES USING SUPERHEATED STEAM are giving much satisfaction on the Canadian Pacific Ry., where 186 are now running or will be soon received from the builders. Three types are employed, one designed by the engineers of the company, who find that the superheater locomotive is very satisfactory and economical in passenger service and its relative performance does not decrease with an increase of speed, as is the case with compounds. On the Rock Island lines, where six passenger superheater locomotives are running, there has been some trouble with clogging of the flues by ash, but in spite of it the locomotives have shown remarkable speed.

AN INTERMITTENT FILTER will shortly be completed for the temporary treatment of the Ludlow reservoir supply of the Springfield, Mass., water-works. Its object is to remove tastes and odors from the water during the anabæna season, and it is not for winter use or for removing a large proportion of bacteria. It was designed by Mr. Allen Hazen, and is being constructed by leveling off an area of about 4 acres on a point projecting into the reservoir, and covering it with coarse sand. Water will be pumped from the reservoir through a 24-in. pipe to an aerating fountain and thence distributed over the filters. The effluent will be collected in 8-in. drains 12½ ft. apart, leading to a collector which terminates in a chamber where aeration will take place.

THIN STEEL SHEETS are so subject to blisters that the study of these defects has been undertaken many times. The latest investigation was that of Mr. Edward F. Law, who explained his methods before the Iron and Steel Institute recently. He concludes that oxidized steel will give rise to blistered sheets, which are more likely to occur with Bessemer than with open-hearth metal, and that steel high in sulphur and carbon will be brittle in sheets, particularly if they are rolled from large and slowly-cooled ingots, in which the maximum segregation has taken place. In the discussion of the paper Mr. T. Vaughan Hughes stated that it was doubtful whether the differences in sulphur and phosphorus contents were the cause or merely an indication of badly-made steel.

ORNAMENTAL CAST-IRON WORK of the best class

is not made to any extent in the Pittsburg district, although there are several large plants there making general ornamental iron work. The reason for this, according to Mr. Chester B. Albree, is that the local job founders make machine castings requiring strong iron but not one that is fine-running. The latter usually has considerable phosphorus in it and is not strong. The result of these conditions is that the business is done by the eastern and western concerns, which have finer sand and pay lower wages and have put in electric bronzing plants, machinery to grind the castings, and facilities for making wax models and plaster molds.

ENGINE VIBRATIONS have been prevented from causing annoyance in the basement of the London house of Mr. S. A. Jinks by the use of a novel platform designed by the owner. The unit is a 20-h.-p. gas engine with extra heavy flywheel which drives a 12½-kw. dynamo. According to "The Engineer," of London, a 5-in. bed of concrete was first laid down, on which ten 3x4½-in. timbers were placed at equal distances apart. A series of 2-in. holes were bored in the top of each timber, and a powerful spring, carrying 5 cwt. with ½-in. compression, was placed in each hole. There are 48 springs in all, and they support a galvanized iron tray 10 ft. long, 5 ft. wide and 5 ft. deep. This holds the concrete base 2 ft. 8 in. thick, on which the engine rests. The exhaust and compressed air connections are of flexible metallic tubing, and the other connections of rubber tube. When the unit was started, it was found to sway longitudinally somewhat, so at each end a timber was placed, high enough to touch the tray without lifting it from the springs.

THE PRESERVATION OF NIAGARA FALLS was the alleged object of a bill recently passed by the New York Legislature and wisely vetoed by Governor Higgins. It contained the following remarkable section: "Corporations organized under the laws of the State of New York, and foreign corporations doing business in the State of New York, and firms and individuals carrying on or conducting business in the State of New York, now engaged in developing power for commercial purposes by the use or the diversion of the waters of the Niagara River above the Falls shall be limited and restricted from and after the passage of this act to a quantity of water equal to the quantity which said corporations, firms or individuals can by virtue of their present rights draw under their respective charters. This section shall not be construed to affirm or impair the existing charter of any corporation, firm or individual." A more ambiguous statement cannot be imagined. If it is merely declaratory of existing laws, it is unnecessary; but if it means that double the present chartered diversion may be authorized it is tricky and has met the fate it deserved. The preservation of Niagara Falls is a subject that is being considerably overworked just now. If the natural beauty of this place were not almost destroyed by ramshackle hotels, hideous signs and other structures offensive to a critical eye, there would be sound reason for regarding any further use of the water for power purpose with disapproval. But the artificial surroundings of the Falls being what they are, there is good ground for argument in favor of using the power for running industrial works, and the improvement of transportation facilities. It might be added that the diversion of water on the Canadian side is likely to be far more serious in its visible effects on the Falls than American diversions have been, and as the people of Canada do not seem to care anything about the matter there is little use in shouting protests across the boundary line from this side of the river.



Mills Building after Earthquake and Fire.

THE STRUCTURAL, MUNICIPAL AND SANITARY ASPECTS OF THE CENTRAL CALIFORNIAN CATASTROPHE.—II.

A STATEMENT OF CONDITIONS PRODUCED BY EARTHQUAKE AND FIRE, AND CONCLUSIONS DRAWN
FROM THEM.

By Charles Gilman Hyde, Assoc. M. Am. Soc. C. E.

Type II, Buildings.—This type of structure under the classification adopted by the writer for his present purpose, fulfills in all respects the requirements of "Class A" buildings described last week, with the exception that the spandrel walls are not wholly supported by the steel framework, but are partly or wholly carried by the foundation directly. They are, however, more or less securely anchored to the framework. There are many interesting examples in San Francisco of this type of construction. Several of these will be briefly described.

HOTEL ALEXANDER.—This hotel is an eleven-story building located on Geary St. just west of the St. Francis Hotel. The Geary St. front is faced with cut gray sandstone blocks, so frequently seen on buildings in San Francisco. The other exterior walls consist of red brick work, carefully attached to the framing by means of anchor bolts having iron plates on the exterior face. This building had just been completed before the earthquake and is said to have been occupied. It appears that the earthquake caused little if any damage, although the building is comparatively tall and only 35 ft. wide in an easterly-westerly direction, in which it appears the greatest vibrations in San Francisco took place. The marble work in the main entrance was not even chipped at the edges, which is rather an unusual circumstance, even for buildings which were otherwise but little injured by the earthquake. The woodwork in windows, doorways, etc., was entirely destroyed by fire, and the sandstone was slightly chipped around the window openings from whence the flames issued.

CALIFORNIA CASKET CO.'S BUILDING.—This building is a seven-story structure located on Mission St., between 5th and 6th Sts. The Mission St. front is of gray sandstone covering the brickwork. The other sides are of rough red brick. This building has a steel frame and the flooring is of the type adopted by the Roebing Construction Co. The building was near-

ing completion at the time of the earthquake and probably contained but very little inflammable material. The earthquake produced some serious cracks in the south brick wall and the sandstone front was badly splintered and cracked in certain portions of the first story. The east and west walls contain many diagonal cracks which must have been caused by the vibrations of the earthquake. The building was not seriously injured by the fire, and it is probable that it was not exposed to a very great external or internal heat. The surrounding buildings were comparatively small. The window casings in the three upper floors are only partly burned. On the Mission St. front the granite base blocks have been badly spotted by the heat. It will be seen how difficult of replacement these are when it is realized that on these blocks rest the superior walls. The problem of renewal would have been simple if the weights of all walls were carried by the steelwork.

CALL BUILDING.—The Call Building, perhaps more properly known as the Claus Spreckels Building, is located at Newspaper Square on Market St., and occupies a very prominent position. It was probably one of the best known buildings in San Francisco. It is sixteen stories in height to the base of the ornamental great dome, which is surmounted by a tower and a smaller dome. This building conforms in every respect, so far as is known to the writer, to the several requirements arbitrarily assumed for this type of building. A superficial examination, only, does not indicate any serious damage by earthquake, nor does it appear that the interior damage by fire is so very great. Flames swept throughout the building, and everything which was inflammable was consumed. It is believed that a very careful examination should be made to determine the exact condition of the steel work and the floors of this building. The exterior cut masonry, wherever exposed to intense heat, is badly spotted and will in many places re-

quire renewal if the good appearance of this structure is to be preserved.

CITY HALL.—One of the most striking structures in San Francisco, both on account of its imposing architectural adornment, and because the administrative work of the city was carried on there, was the City Hall, on Market St., west of Leavenworth. It was almost entirely destroyed by the earthquake. The exterior walls were of brickwork, faced with cut gray sandstone blocks. A tower, surmounted by a great dome was one of the leading features of this building. It comprised a light steel frame, surrounding which were walls of brick faced with sandstone blocks and ornamental columns. These walls were not, evidently, anchored to the steel work, and the oscillations caused by the earthquake were sufficiently severe to break such slight anchorages as had been provided, and to cast almost the entire shell of masonry to the ground, destroying the main portions of the building.

FAIRMOUNT HOTEL.—This great building, located on California St. near the summit of Nob Hill, is to-day, without question, one of the most prominent landmarks in San Francisco, as it also was before the fire occurred. It has a steel framework, with reinforced concrete floors. The basement walls are of concrete; those of the first story are brick faced with cut granite, and those of the upper stories are faced with light cream colored hollow tiles. The effect of the earthquake on this building was very marked in certain places, especially on the north face. Here the "X" lines of rupture in the hollow tile construction are very prominent, especially between the first and second floors. Fire swept through this building, destroying all of the woodwork and furnishings. Wherever the flames were carried outward through the windows and door openings destruction of the facing materials resulted. This was to have been expected in the case of the granite blocks of the first story, but it would not probably be anticipated in the case of the hollow tiles of the particular type used in this building.

GRANT BUILDING.—This building is an eight-story structure, located on Market St. at the corner of 7th St. It has a steel frame with riveted steel columns, girders and beams and reinforced concrete floors in which expanded metal was evidently used. The steel framing was generally protected by expanded metal screen walls plastered with Portland cement mortar. In some cases the horizontal I-beams of the floors were protected on their lower flange by cast-iron ornamental plates. The exterior masonry fronting on the street is faced with brown pressed bricks, elsewhere the walls are of ordinary brick masonry. This building externally appears to have received very little injury from the vibrations caused by the earthquake. The heavy cornice is intact throughout, and it appears that it is firmly anchored to the steel frame. The partitions of thin hollow tiles were very generally destroyed. Fire swept through the greater portion of this building, destroying all the woodwork. A superficial examination does not indicate any serious injury to the steel work, floors or exterior walls, and it appears that the damage by fire may be quite readily repaired.

KAMM BUILDING.—This building is located on Market St. near Newspaper Square, and two views of it were printed in The Engineering Record of May 26. It has a steel frame and sandstone block front, with very plain light cornice. The exterior walls are of red brickwork and the floors and partitions are of the Roebing fireproof construction. The front portion of the building, on Market St., withstood the earthquake very satisfactorily, and was apparently not very badly damaged by the fire. The west wall of red brickwork was apparently not very well anchored to the steel frame, as it was very considerably bulged out and otherwise dam-

aged. The rear or south wall of the building in its upper portion has completely fallen away, probably as the result, first of the earthquake and secondly of the fire. The upper windows of the west wall of this building were protected by metal blinds, arranged to roll into a housing attached to the outer face of the masonry. Some of these housings were entirely destroyed, indicating that they were poorly constructed, and badly arranged and were not properly anchored to the brickwork.

MILLS BUILDING.—The Mills Building is a very large structure located on Montgomery St. not far from Market. It is ten stories in height and has a steel framework like the other buildings of this type. The floors and interior partitions are of hollow tiles. The exterior walls fronting on streets are faced with cut marble for the first two stories; yellow pressed brick with terra-cotta ornamentations for the remaining eight stories. The building appears to have been subjected to considerable heat on the east and

is stated that safes from the top stories fell to the basement through the terra cotta floors.

MONADNOCK BUILDING.—This building is situated on Market St., just west of the Palace Hotel, in the region known as Newspaper Square. It is a ten-story structure with a rather light steel frame, and exterior walls of brick faced on the sides fronting streets with sandstone for the first two stories and with yellow pressed brick and terra-cotta tiles for the remaining eight stories. This building was in the process of erection and had not been occupied up to the time of the fire. The brickwork was apparently very seriously damaged by the earthquake, especially at the southeast and northeast corners, where very large and significant cracks were created. This feature appears to be not unusual with this class of building, where the walls are not carefully anchored to the framework. The building was not very seriously injured by fire, and in fact there was very little combustible material within it.

UNITED STATES POST OFFICE.—This magnificent

It is evident that the building itself settled slightly, inasmuch as serious cracks were developed in the granite facing at the southwest, northwest and the northeast corners, and these cracks presumably extend into the brick work. Within the building the floors and ceilings, which in the main corridors have beautiful mosaic surfaces, appear to be almost unharmed, but the hollow tile partitions consisting of double rows of blocks on main corridors faced with polished marble slabs have been broken and thrown down at very many points, showing the unsuitability of this mode of construction in regions subject to earthquakes. Fire did not break out in this building, and it therefore offers a very excellent opportunity for careful study of the effect of earthquake upon this type of structure.

NEW TELEPHONE BUILDING.—This building is located on Bush St. between Kearney and Grant Ave., opposite the place where the California Hotel and Theater stood. It is eight stories high, with steel frame and reinforced concrete



Monadnock and Call Buildings.

The City Hall.

north sides. The fire swept throughout the building, destroying the contents of the rooms and practically all the woodwork. The building appears to have been only slightly damaged by the earthquake, but the destruction by fire has been very considerable. The marble facing on the two lower stories has been very considerably spalled, to a point far beyond hope of repair, by the flames which swept outward through the window and door openings. This condition is the more serious because the exterior walls are not carried by a steel frame as in "Class A" buildings, but are supported from the bottom upwards by the foundations. The terra-cotta ornamentations, lintels, sills, etc., have been very much injured, in some cases being entirely destroyed. The interior fire is said to have been so hot in the basement that in some instances the metal in the columns flowed and one Z-bar column was badly twisted; and one built channel column became knotted. The terra-cotta floors and partitions are in very bad shape, in some cases wholly destroyed. It

structure is located on Mission St., just east of 7th, and was illustrated in The Engineering Record of June 2, page 695. It is especially noteworthy since it is built upon filled land which everywhere in San Francisco was shown to be very unstable and capable of very great distortion and settlement as a result of the action of the oscillations and vibrations due to the earthquake. This building has pile foundations carefully designed and driven. They are capped with concrete. The building has a steel framework carrying the interior walls and partitions, but the exterior walls are independent and are carried by the foundations directly. These walls, on all sides of the building, consist of brick masonry faced with finely cut granite blocks.

The effect of the earthquake throughout this vicinity has been most marked. Streets in this neighborhood have settled very considerably and the sidewalk has also seriously sunk. Mission St., at the corner of 7th, has been thrown bodily southward to the extent of at least two feet.

floors, and an illustration of it appeared in The Engineering Record of May 26, page 642. The exterior walls on three sides are of red brick, and the wall fronting on Bush St. has a yellow pressed brick and terra-cotta facing. The windows are provided with frames of metal and the two lower stories are glazed with wire-ribbed glass; the upper ones have plain glass. To the writer this building has a peculiar interest in that it is the only one in San Francisco which, so far as his knowledge extends, received protection in windows from adequately designed and constructed fireproof blinds or shutters.

The effect of the earthquake is indicated particularly on the west wall, in the middle third of the height, where the brick pilasters surrounding the vertical columns were largely loosened and thrown down. A number of diagonal cracks appear in this wall and smaller ones are to be found in the front walls, on Bush St.

This building was exposed to an exceedingly hot fire. The protection afforded by the Venetian



U. S. Appraiser's Warehouse.



Western Electric Co. Building.

blinds appears to have been very adequate. It is stated that the heat within the building was so great both from the fire without and the smaller fire, which is said to have passed upward through the elevator shaft, that the glass cells of the storage batteries were melted into a fluid which ran out upon the floor. Flames did not break out in these rooms, however, owing to the exclusion of air by the metal window screens, doors, etc. It is stated that curtains hung at the windows were charred and fell to the floor without producing flame. As already stated, this building is believed to be the only one in San Francisco provided with adequate fire screens at windows and doors. These are of a type which may be rolled up into the metal window frames, or into a chamber provided for them within the walls of the building, and are not, therefore, a disfigurement in any respect.

There are several other buildings in San Francisco, notably the Rialto Building and the Wells-Fargo Building, which might be classed with this type of construction. In the case of the latter structure, typical earthquake cracks were produced in the brickwork of the vertical pilasters of the front face on Mission St.

UNION SAVINGS BANK BUILDING.—This building is located on Broadway at the corner of 13th St., in Oakland, on the east shore of San Francisco Bay, where the vibrations caused by the temblor were probably not as severe as those produced on the San Francisco peninsula. This building is ten stories in height. It has a facing of gray sandstone on the Broadway and 13th

St. sides; the other sides are entirely of red brickwork. The building has a steel framework and, it is believed, reinforced concrete floors.

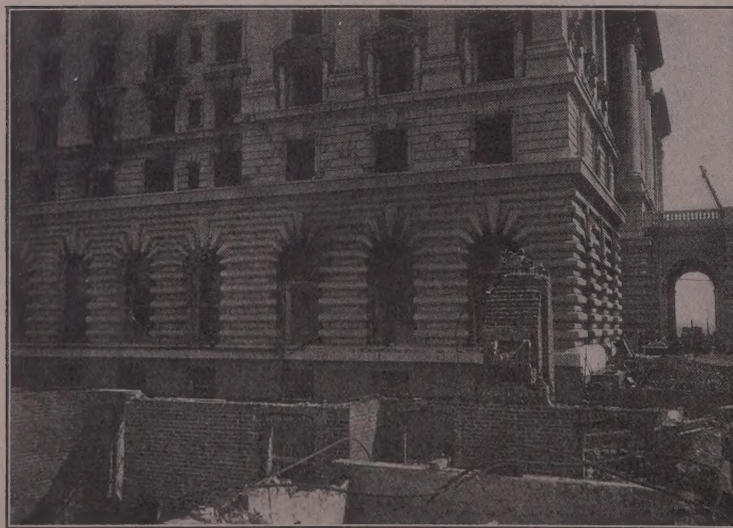
No fire occurred in or around this building, nor in fact did any serious fires gain headway in the city of Oakland as a result of the earthquake. The principal damage to this building seems to have been produced in the brick walls near the floor lines, especially between the second and seventh stories, where considerable bulging has taken place, as was noted in the case of the Atlas Building, previously described. In certain places between stories, these walls were cracked in the "X" shape typical of earthquake effect. On the north wall of this building, several brick window arches were broken out and thrown down on to the roofs of adjacent low buildings. It is evident from this example and many others that specifications requiring Portland cement for all brickwork must be carefully drawn and enforced.

Type III. Buildings.—As already briefly described, the structures which might be classified as fulfilling the conditions of this type, are those having reasonably heavy masonry exterior walls carried directly by the foundations. These structures do not have interior steel work, but comprehend interior walls of solid masonry, firmly bound together by efficient anchors, and by longitudinal steel reinforcements, giving adequate lateral stability to the exterior walls. The classification states nothing with respect to fireproof qualities.

Although it did not exist in San Francisco for

reasons which will be later explained, it is at once apparent that no form of construction can fulfill the requirements of this type so completely or so well as reinforced concrete. This material admits of such design and use as will give maximum lateral rigidity and stability which, together with fireproof qualities, are the elements most necessary to meet municipal structural conditions in regions likely to be affected by seismic disturbances.

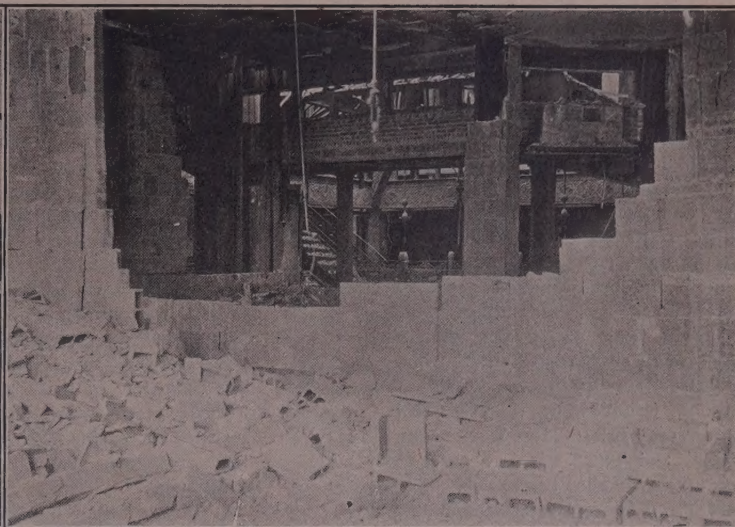
PALACE HOTEL.—This famous caravansary, located on Market St., just east of Third, probably more completely fulfills the conditions of this type of structure than any other in San Francisco. It was constructed many years ago of brick masonry reinforced longitudinally with flat strips of iron or steel. Many interior cross-walls divided the structure into comparatively small portions, which, had they been separated by fireproof doors, would have served to confine to relatively small space, any fires taking place within the building, even though the floors themselves, which were constructed of timber, were burned. In other words, only one portion of the building from top to bottom would certainly have been destroyed by such a fire originating from within. The Palace Hotel is seven stories in height. It appears that no serious damage was caused by the earthquake, although some plaster was shaken down in some portions of the building. It is stated that book cases on the north and south walls of this building were undisturbed, but those on the east and west walls were thrown westward. This information is very interesting



Two Views of the Fairmount Hotel, a Building of Type 2.



Houses on Soft Ground.



Interior of Mills Building.

in that it corroborates evidence obtained elsewhere which indicates that the greatest vibration on the San Francisco peninsula was in an easterly and westerly direction, rather than northerly and southerly. The building was wholly destroyed by fire, and only the brick walls now remain to show where this well-known structure once stood.

UNITED STATES APPRAISER'S OFFICE.—Perhaps the U. S. Appraiser's Office, on Sansome St., between Washington and Jackson Streets, might be classed as a structure of this type. The exterior red brick walls are very thick, 36 ins., and are said to be reinforced both vertically and horizontally with steel rods. The building appears to have been not at all injured by the earthquake, no cracks appearing anywhere in the ex-

ternal brickwork and none on the interior. No plastering was thrown from the walls or ceilings, although the shock in this vicinity must have been considerable, because a rather large building directly across Sansome St. was very badly wrecked by the earthquake. Since no observable distortion of streets in this vicinity was produced, it is safe to assume that ordinary foundations were upon firm material.

Type IV.—Buildings of this type have been arbitrarily classified by the writer to include those having exterior walls of masonry resting directly upon the foundations. Like Type III buildings, they can in no respect be considered fire-proof, but this construction should at least be equivalent to the usual "slow burning" types. The exterior walls of such buildings commonly receive

very little lateral stiffening or lateral support from the interior construction, which may be, and usually is, of steel, whose horizontal members simply rest in niches provided for them in the exterior walls. Wooden beams are generally likewise placed.

COWELL BUILDING.—This building was located at the southeast corner of Sansome and Merchant Sts. and was a seven-story structure. The exterior walls fronting on streets had a base course of granite on which was superposed red brick walls faced with pressed buff brick. Hollow tiles were used as a belt course at the top of the second story, and for all window lintels and sills above the first floor. The partitions and floors of the building were carried by unprotected riveted steel columns and girders. Cast-iron columns



Typical Earthquake Cracks.



Townsend Street Power Plant.

were used to support the masonry over large openings in the first floor. It is impossible to discover what the effect of the earthquake was upon this building. For its class it represented good construction, but its type was one which should not be found in the midst of a great city. The building was exposed to an exceedingly hot fire, both from without due to the burning of adjacent structures and from within, owing to the inflammable nature of its contents, the building having been for the most part, it is understood, occupied by printers and book binders. Fire swept through this building and left nothing standing except the outer walls and a few badly twisted steel members of the original interior framework.

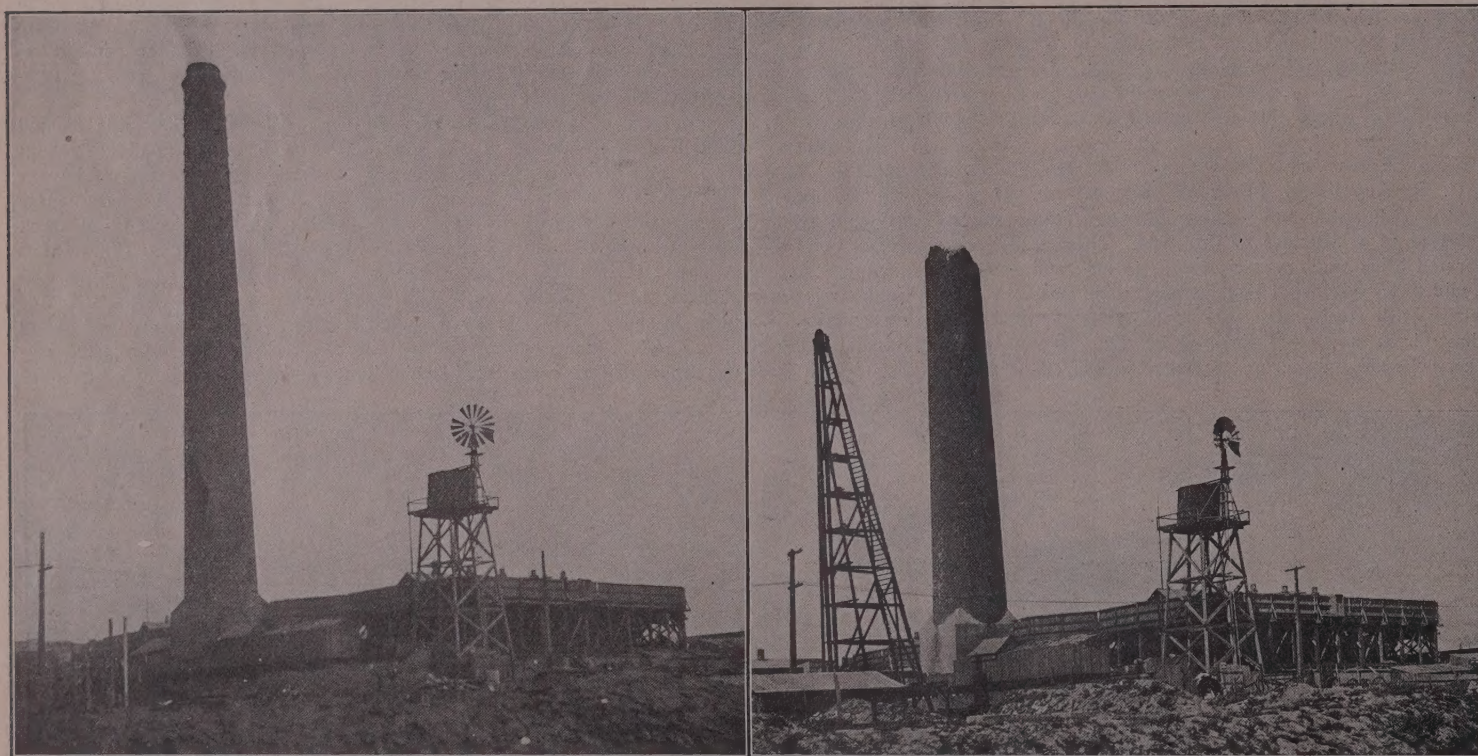
CALIFORNIA ELECTRICAL CO.'S WORKS.—The building occupied by the California Electrical Co.'s Works is located at 642 Folsom St., between Second and Third. It is a three-story building with exterior walls of red brick. The interior construction of floors, beams and columns is of wood, designed in accordance with what is known as "slow burning mill construction." The window frames are entirely of metal, and are glazed with wire glass. The building was subjected to con-

tinguishers, of which generous provision had been made. Electricity was cut off from the building at the very beginning of the fire, so that the electric pump was thrown out of service. On this account the storage in the tank in the basement of the building could not be used and the only water available was that in the upper tank. However, the building was saved, and very little damage was caused. A full account of the saving of the building was printed in *The Engineering Record* of May 12.

Type VI, Chimneys.—In connection with industrial establishments there were very many brick chimneys—some very large, some of moderate size—scattered throughout the city of San Francisco. A few of these remain intact and undisturbed; others were entirely destroyed by the force of the earthquake. Among chimneys which were apparently unharmed, the following may be mentioned:

1. That of the Townsend St. power house of the San Francisco Gas & Electric Co., known as "Sub Station No. 8," on Townsend St., near Third. The writer estimates that this chimney is about 125 ft. high. A careful inspection does

1. **Chimney of Garbage Destructor, San Francisco.**—One of the most important chimneys almost totally destroyed by the earthquake was that of the garbage destructor works, near the corner of Alameda and Kansas Sts. This chimney was constructed about ten years ago and at that time was the largest in use in the world in connection with refuse destruction. It has remained probably the largest chimney on the Pacific Coast. Its location is just within the filled area of the old Mission Bay region. It was 265 ft. high and 32 ft. square at the base above the ground line. The circular portion, above the square base, was 210 ft. high. The foundations of concrete were carried very deep and by successive steps outward the area of support was increased to 2,500 sq. ft. The vertical flue at the base, at the point of entrance of the lateral flues from the furnaces on either side, is 14 ft. square. The force of the temblor was such as to rupture the stack at a point about 65 ft. below the top. This portion fell, partly inside and partly outside of the chimney. The masses falling outside destroyed portions of the lateral flues, which were semi-circular in shape, 14 ft. wide at the base and 10 ft. 9 in.



Two Views of the 265-Foot Stack of the Garbage Destructor.

siderable external heat on the north and west sides. It was provided with a riveted steel water tank having a capacity of 50,000 gal., placed on two elevated brick walls, at right angles, carried several feet above the roof. Moreover, a tank having the capacity of 120,000 gal. was provided in the basement. A means of raising water from the lower tank to the upper one was provided by a pump electrically operated.

The effect of the earthquake upon this building was not serious. A large portion of the fire or parapet wall was thrown down, and a part of the main brick wall of the building at the northwest corner was also overthrown. Cracks were formed in the masonry supports of the elevated water tank.

The heat from the burning buildings surrounding this structure was sufficient to melt the wire glass panes in one or two of the windows and to cause these to run slightly. The window curtains were charred and fell to the ground, but did not break into flame. Fire broke out in several parts of the building, but was extinguished by the water from the elevated tank and by the use of hand ex-

tinguishers, of which generous provision had been made. Electricity was cut off from the building at the very beginning of the fire, so that the electric pump was thrown out of service. On this account the storage in the tank in the basement of the building could not be used and the only water available was that in the upper tank. However, the building was saved, and very little damage was caused. A full account of the saving of the building was printed in *The Engineering Record* of May 12.

2. The chimneys of the power house of the United Railroads Co., at 16th and Harrison Sts., also rested upon rock foundations and were practically unharmed.

3. The chimney of Wieland's Brewery on Second St., near Folsom, appears not to have been injuriously affected by the earthquake. A cross-section of this chimney is peculiar in that it consists of a number of re-entrant angles forming a star.

Other chimneys, perhaps not so advantageously situated, although correctly constructed, were less fortunate, and were either partly or wholly destroyed by the force of the temblor. The writer examined several of these chimneys, and was fortunate in being able to secure photographs of several of them.

high. The upper part of the stack of the chimney, which is still standing, is very seriously cracked for a considerable distance downward. It is possible that this badly injured portion can be torn down and the remainder repaired in a manner which will allow of use in connection with forced draft. One man was killed by the masses of brickwork falling from this chimney.

2. **German Hospital Chimney.**—This was completed some six months ago. It was constructed with a massive concrete base, and stack of brickwork surmounted by a reinforced concrete cap weighing seven tons. The concrete foundation, resting upon hard clay, is 16 ft. square and 6 ft. deep. The stack is 9 ft. 6 in. square at the base, 6 ft. square at the top and is 126 ft. high. Although it remained standing, the earthquake produced very serious cracks in the upper portion, from 20 to 50 ft. below the top, on the southwest side. It appears probable that the reinforced concrete cap prevented rupture of the brickwork in the upper 20 ft.

3. **Chimney of Station C, San Francisco Gas & Electric Co.**—Station C of the San Francisco Gas

& Electric Co. is located on Jesse St., between Third and Fourth Sts. The large circular brick chimney connected with this plant was totally ruined by the earthquake. The upper portion, which crumbled and fell, destroyed a part of the roof of the power house, tore down the flue connections and killed one man. The lower portion of the chimney which remained standing is seriously cracked and appears to be in a precarious condition. The plant was devastated by the fire, which later swept through this section of the city.

Type VII, Bridges.—Very little information has as yet come to the hands of the writer with respect to the effect of the earthquake upon bridges of various types. It is evident that structures pertaining to railroads suffered severely in common with others. It is a well-known fact that many embankments were seriously distorted in alignment and were reduced in elevation through settlement due to the vibration. Landslides were not uncommon on hillsides and in cuts where

The Works of the Mexican Light & Power Co., Ltd.

The recent opening of the works for developing the power of the Necaxa waterfall, 95 miles from the city of Mexico, was an event of considerable engineering importance, as well as significant of the progressive methods now adopted in and about the capital of the sister Republic. The first proposition to utilize this power was made by Dr. Vaquie, a French resident of the city, who suggested locating various industries at Necaxa. Among his friends in Mexico and Paris, Dr. Vaquil organized a company called the *Compagnie du Necaxa*, with a small capitalization, and work was begun at the falls. Property was acquired, including the mesa, where are now located the works of the present company, and the valley in which the present power house is

\$13,000,000. Bonds were issued to the amount of \$12,000,000, Canadian currency.

In March, 1903, the Mexican Government granted to the company a concession for the utilization of the waters of the Necaxa and Tenango rivers for power generation. This concession was ratified by the Mexican Congress on May 20, 1903, and included and enlarged the original concession to Dr. Vaquie. Subsequently concessions were obtained from the municipal council of the city of Mexico and the States of Puebla, Hidalgo, Mexico and Michoacan, under which the company is now generating, selling and distributing electricity.

In October, 1903, the company acquired the properties and franchises of the *Compania Mexicana de Electricidad*, which then controlled the public lighting of the City of Mexico and in a number of towns in the Federal District, besides a large private consumption of light and power in the city and suburbs.



Pipe Lines from Tunnel Number Five.



Lower Necaxa Falls, Power House and Camp.

both railroads and highways, principally the former, were located.

The bascule bridge recently erected by the Southern Pacific Company across the San Francisco River, so-called, at the foot of Channel St., near the water front, was seriously crippled by the settlement, to the extent of 4 in., of the east corner of the south abutment. This movement was sufficient to render operation impossible. It is stated that another bridge of the Southern Pacific Company, one of five spans crossing the Pajaro River in the vicinity of Chittenden Station, was thrown from its seats. Happily the injury in this case was not serious and the remedy was easy to apply. Some of the intermediate concrete piers, with granite copings, are said to have been cracked.

(To be Continued.)

THE SIMPLON TUNNEL was formally opened last month by the King of Italy, whose train was drawn by a steam locomotive on account of the non-arrival of electric locomotives.

located. Substantial buildings were put up, which are now in use there, and a fine trail built down the mountain side to the south of the falls, in another valley. Little else was done, although, in all, about \$100,000, Mexican currency, was expended.

When long-distance electrical transmission became a reality, Dr. Vaquie's company realized that the Necaxa power could best be sold in Mexico City, and at the same time that it could not attempt to finance such a stupendous enterprise, and the rights to the falls were offered for sale. Through local parties, the matter was brought to the attention of the financial interests of the Bank of Montreal, and Dr. F. S. Pearson began negotiations for the purchase of the rights to the water power. Matters were finally arranged and the sale consummated, the properties and rights of the *Compagnie du Necaxa* passing to the Mexican Light & Power Company, of Montreal. This was organized in 1902, under the laws of the Dominion of Canada, with head offices in the city of Montreal. The capital stock was

In July, 1904, the Mexican Light & Power Co. promoted a new lighting company, the Mexican Electric Light Co., with a capital of \$6,000,000 gold in bonds and \$6,000,000 in capital stock, for the purchase of the two other lighting companies then doing business in the city, *La Compania Exploradora de las Fuerzas Hidro-electricas de San Ildefonso, S. A.*, and the Mexican Gas & Electric Light Co. The purchase of these two companies has only recently been effected, and the properties have been transferred to the Mexican Electric Light Co., all of the capital stock of which is now owned by the Mexican Light & Power Co., the directors and managers of the companies being identical. The following account of the works is abridged from an elaborate article in "Modern Mexico," while the illustrations are from photographs furnished by Dr. Pearson.

The original scheme of development at Necaxa, the carrying out of which is now well under way, was to turn the Tenango River into the Necaxa some miles above the falls of the two rivers, by

means of a diverting dam and a tunnel. This diverting dam will be 30 ft. in height at its highest point, 830 ft. long and 120 ft. wide at its base. The tunnel, now finished and in use, is 11x7 ft. in cross section, and 3,000 ft. long, lined with concrete.

The base rock over the larger portion of the country is volcanic, the valleys of the Necaxa and Tenango rivers and the range of low hills which separate them being of this formation, while the mountains on either side are of limestone, the basalt formation between being evidently an intrusion of comparatively recent geologic age. This volcanic formation makes an unreliable base for the site of a stone dam, so earth dams were decided on for all locations. These are to be built by the old method of sluicing, which has been used so successfully in the Western part of the United States. The water is brought in by means of sluice ditches high on the hillsides, and with the head thus gained, earth and stones are washed into pipes laid on scaffolding, which carry the water and sediment to the dam site, where, against toes built of stones, it is deposited, and the water run off, the method being so arranged that the heavy material stays at the outside and the lighter settles slowly in the inside of the work. As far as possible, the water used in sluicing is

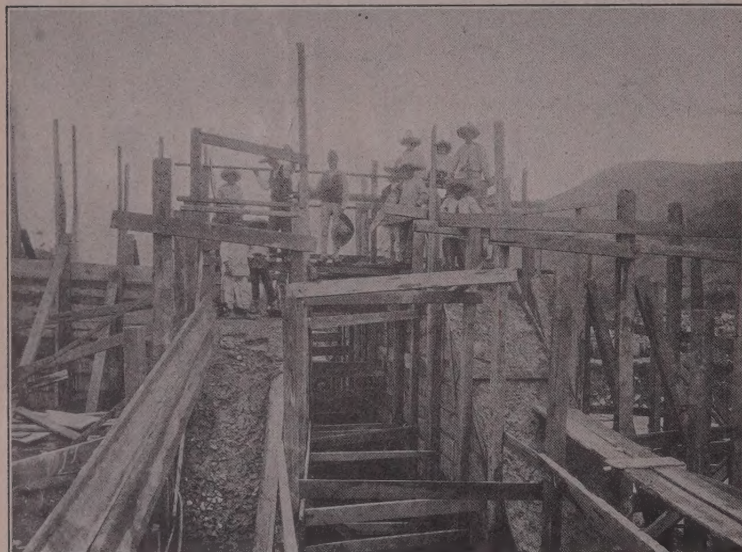
vision of a masonry core 12 ft. thick. The slopes of the earthwork on this dam will be 3 in 1 on the up-stream side, and 2 in 1 on the down-stream side. Its storage capacity will be 630,000,000 cu. ft.

But a short distance below the Tescapa dam and almost at the mouth of the tunnel from the Tenango, will lie the headwaters of the last reservoir, from the dam some three miles below. This dam will be built at the foot of the mesa, where the main construction camp of the company is located, and will completely cover with water, when it is finished, the little town of Necaxa, immediately below. It is being built between two promontories, and the narrow space between the hills makes possible the conservation of a very considerable body of water with a comparatively narrow dam. This dam, on the same plan as the Tescapa dam, as regards masonry core and the slope of the sides of the finished structure, will be 177 ft. high, 1,300 ft. long at the crest, and 970 ft. wide at the base. About 2,000,000 cu. yd. of material will be used in its construction. The sluicing ditch for both the Tescapa dam and the Necaxa dam will be the same, and will have a length of some 11 miles. It will be about 450 feet above the lower dam, giving a splendid head for sluicing work. The

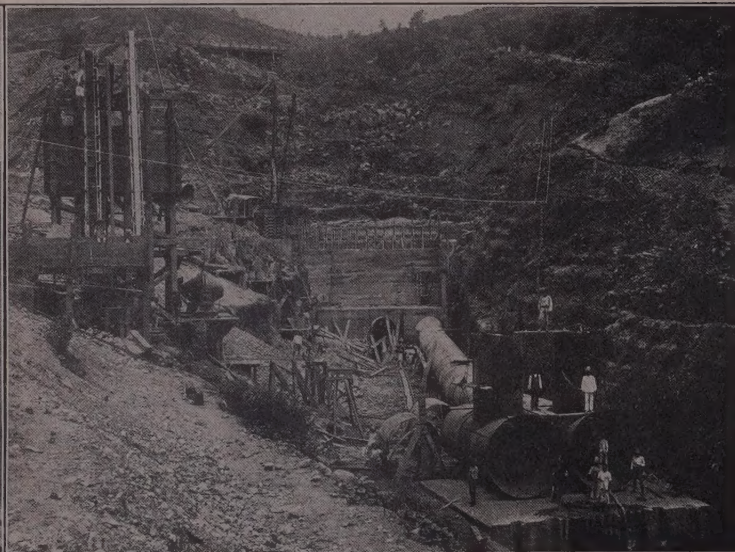
A temporary dam, with a length of 400 ft., and a height of 30 ft., is now in course of construction, and when finished will have a reservoir capacity of 490,000,000 cu. ft. This temporary dam will form the up-stream toe of the permanent dam, and will provide storage this year to carry over to the dry season, enough water to allow the Necaxa plant to handle a large percentage of the company's load, even increased, as it will necessarily be. When the two lower dams are completed, the company will have a storage capacity which, it is estimated, will be sufficient to catch and hold all water which falls during the wet season, and the water will be amply sufficient, and that with little waste of reservoir space, to run the plant to its full capacity the year around.

To fill this great reservoir, the Mexican Light & Power Co. has the water in the three streams mentioned above, which belong to the Necaxa valley, for the waters of which the company holds a concession. In addition, applications have been made for the use of the waters in adjacent valleys, and by an elaborate system of canals, embracing some twenty or thirty kilometers on one side, and twenty on the other, these waters will be diverted and emptied into the Laguna basin.

When the present Necaxa power development



Constructing Dam Number One.



Typical Concrete Plant.

diverted to the back of the dam, where it is saved, and at the same time serves as a continual test of the efficiency of the dam it is building. The Tenango dam will be arranged only for diversion, although there will be a small storage capacity, sufficient to hold back enough water during the lighter hours of the day to materially assist in handling the peak load at the plant below, until the other dams are finished, and water is conserved in the large reservoirs for all such purposes.

Just above the point where the diverted water of the Tenango River enters the Necaxa through the tunnel, is being built another dam, known as No. 3 or Tescapa dam, named from the little town nearby, now principally a construction camp. In the original plans this was the first of the dams to catch the water of the Necaxa River, and while the construction here will call for a high dam in proportion to the amount of water conserved, it will be a very necessary link in the chain of reservoirs. This dam will have a height of 155 ft., and will stretch 1,140 ft. from side to side of the barranca. Its width will be 810 ft. at the base, and the spillway, as in the Tenango dam, will be in the center of the river channel. This will be an earth dam with the extra pro-

Necaxa dam will form a reservoir with a capacity of 1,540,000,000 cu. ft. The spillway for this reservoir will be located to the left of the dam site, over a bit of land lower than the mesa, and into a valley which was, probably, at one time, one of the outlets of the lake which apparently covered the area of the reservoir.

Since these dams were planned and laid out, a fourth dam, the Laguna, for storage, has been planned, at a much less cost than the others, yet with a reservoir capacity greater than the combined capacity of the two others. A short ride from Carmen, the terminus of the Mexican Light & Power Co.'s railroad, is a valley into which three little rivers can be drained. From the present look of the country it was at one time a great lake, into which flowed these and perhaps other rivers. There was but one outlet, and that down toward the valley of the Necaxa, as it is now known. The little stream that sometimes served as an outlet for the valley, gradually cut away the retaining wall, and allowed the little rivers to drain through the gap. The simple filling of this gap with a low dam, will be sufficient to conserve 2,450,000,000 cu. ft. of water. This dam will be approximately 2,600 ft. long and 66 ft. high at its highest point.

has been completed, as it will before these dams are entirely finished, another power house will be built above the Tescapa dam, on the hillside below the Laguna reservoir. Here, with the construction of two miles of grade pipeline and a half mile of drop pipeline, a 2,100-ft. head will be obtained. With this head, 80,000 or 100,000 h.p. can be generated here. With the additional power which the Laguna reservoir will give, allowing, as it will, an increase in the power houses below the Necaxa falls, the total available power will eventually be close to 200,000 h.p. The water from the Laguna reservoir, which will be used in the Laguna power house, will not be lost, but will empty in its turn into the Tescapa reservoir, to be used again below Necaxa, in the present and future power houses at the lower level.

The Laguna power plant development, as outlined above, will be at a very small additional cost, and, even with the cost of the reservoir dam at Laguna added in, its initial cost will be vastly less than that of the Necaxa plant, and with a considerably greater power development. It has been proposed to develop the second power house below the present one, where, without additional reservoir space, more than would be necessary to gather the waters together for direction into the

pipes, a head of 700 ft. will be available. This power will no doubt be developed later, but the second power house to be built will be that at Laguna.

The plans of the company call for a large expenditure on dams and canals for conserving the water supply, but in Mexico one cannot depend on the minimum flow of the streams for power, for here the minimum flow is 70 cu. ft. per second, while the maximum flow, at the height of the wet season, is 315 cu. ft. per second. Reservoir capacity is an absolute necessity.

A very interesting detail is added to this water question by the estimate of the proportion of stored water to running water that will be used by the finished power plant when all reservoirs are completed and the plant in full operation. For three years the company has kept accurate record of the flow of the Necaxa and Tenango rivers, and the lowest estimate of the total annual flow is 8,750,000,000 cu. ft. The approximate storage capacity of the Tenango, Tescapa and Necaxa reservoirs is 2,240,000,000 cu. ft., and that of the Laguna basin 2,450,000,000, a total of 4,690,000,000 cu. ft. of reservoir capacity. As the estimates of the engineers have naturally made the reservoir capacity little more than is necessary to actually run the plant, it is fair to estimate that approximately all of this reservoir water will be used each year, so that the stored water will be 52 per cent. of the total flow of the streams, at once an immense percentage and an immense surety of the absolute reliability of the water service at Necaxa. This great reservoir capacity, with the additional insurance of the steam plants of Mexico City and the water power from the San Ildefonso plants in the valley of Mexico, makes, to the consumer, a promise of continuity of service and permanency of supply.

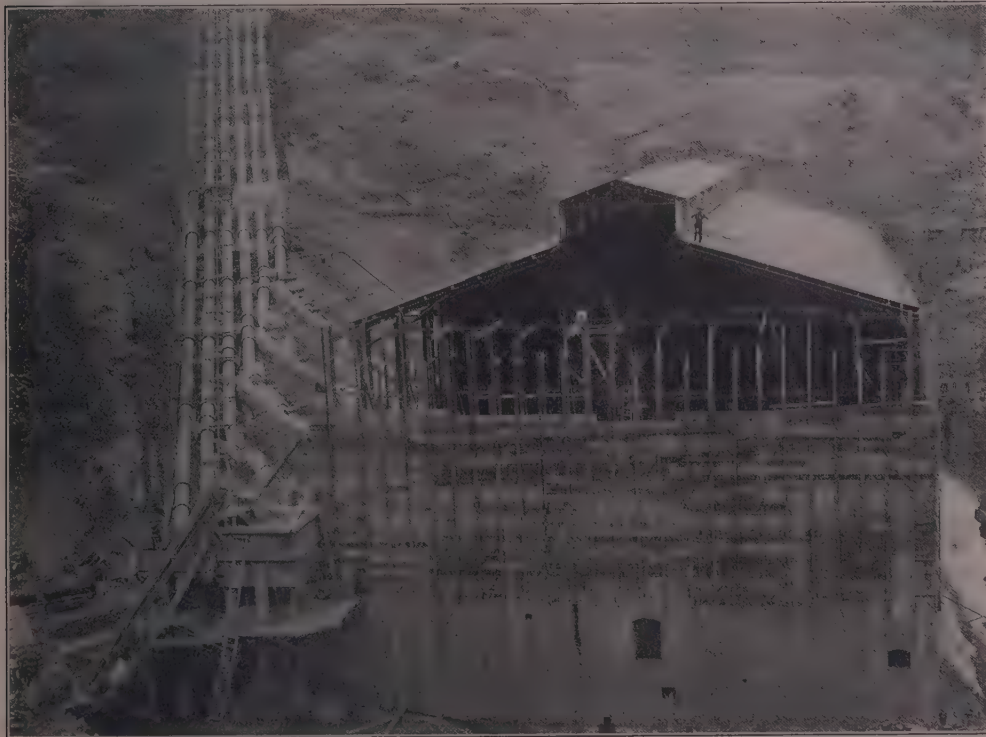
The Mexican Light & Power Co. has done, and will do all of its own construction work. A great

sanitary ground, on one side of the site of the lower dam, is a model of its kind, and the little town of Canadita, just above it, built by the company to replace Necaxa, which is to be flooded by the lower reservoir, is a pleasant suburb for Jacksonville. On the opposite side of the reservoir is the main construction camp, where are located rows of comfortable cabins and bunk-houses for the upper-class employees, built around

minus of the Hidalgo Railroad, by means of 21 miles of narrow-gauge private railroad owned and operated by the Mexican Light & Power Co. The route of this railroad was the original highway, laid out with a view to using traction engines and heavy wagons for the transportation of machinery and supplies. This highway was splendidly constructed, but during the rainy season transportation was so difficult and expensive



Constructing the Tenango or Number One Dam by Sluicing.



Power House No. 1 and Pipe Lines on March 30, 1906.

deal of money was spent in the beginning, and some mistakes made, but the company now has a thoroughly organized construction camp, a commissary department and a health department that are almost above criticism, and an organization of its labor as perfect as any construction company or large contractor could have. The native town, Jacksonville, which is built on splendid

the comfortable and roomy house originally constructed by the French company, now used as a guest house, and attached to the well equipped and splendidly commissaried mess house for the single male employees. On the mesa, too, are located the roomy offices, the shops and the big storehouses.

Necaxa is reached from Berestain, the ter-

that the effort to use traction engines was finally given up and the railroad put in. The grading for the highway was used almost without change for the railway, making a very good roadbed, although with heavy grades and sharp curves. The rolling stock consists of three Shay engines, six Porter engines, for work about the construction works, twenty flat cars and a combination baggage car and coach. The fuel used is Cardiff coal.

Through the construction work above the first waterfall, some six miles of railroad have been built, and serve as a means for transporting all heavy machinery and construction material. It also reaches the elevator cages in which all machinery has been transported to the power house and the construction below the upper fall.

The head at Necaxa is secured by taking the water from the stream and the reservoirs above the first of a series of two waterfalls, the first 460 the second 740 ft. in height. It is from a distance of 4,350 ft. back of this fall, and through three tunnels, that the water is brought in 6-ft. pipes from the lowest, or Necaxa reservoir. The outlet from this reservoir is through two horizontal penstocks of steel pipes 8 ft. in diameter, laid in tunnels 1,550 ft. long, driven through the rock to the south of the dam. Water is admitted to these pipes through screens which open into two vertical pipes imbedded in concrete, each pipe having gates at four different levels, so that the gates will not have to be opened under pressure. At present, a canal 2,600 ft. long leads back from the lowest of these gates, and in this canal the extra water of the hours of the light load of the plant is conserved against the heavy load of later. Where the pipes leave the tunnel, there is a temporary spill valve, from which the surplus water is taken out, and allowed to run down the stream, in order that no water may find its way

back to the bed of the stream before passing the site of the dam, where two steam shovels and an army of laborers, are engaged on the construction of the earthen dam.

The penstocks, after leaving the tunnel, are reduced to a diameter of 6 ft. At intervals on the line, the pipes are fitted with flexible drums, to allow for expansion and contraction. From the mouth of the tunnel, the piping is carried in an almost direct line 2,800 ft., and through 900 ft. more of tunnels to a point just above the first waterfall.

Here the two 6-ft. pipes are joined by means of a receiver 22 ft. long and 7 ft. in diameter, from which six smaller pipes, each 30 in. in diameter, lead out and are carried through the hill to the power house, 1,200 ft. below, each pipe leading to one of the turbines, this arrangement giving a control of the water to the individual machines before it starts on the slope and obtains any great pressure. Just before these six pipes enter the tunnels, a standpipe is led off from each of them, this pipe being laid against the hill and rising at an angle of 45 deg. These standpipes are always open, and as they extend above the level of the water in the Necaxa reservoir, from which the head is obtained, under normal conditions there is no overflow through them. They allow, however, for the escape of water under unexpected high pressure above or sudden shutdown below, and also serve as safety valves for the entrance of air in the case of a break in the pipes, which otherwise would cause a collapse in the pipes as a result of the vacuum created.

The six 30-in. pipes are joined to the 7-ft. receiver in such a way that all, or any part of them, can be fed from one of the 6-foot feeders, or each of the two sets of three each with the 6-ft. feeder entering them direct, can be cut off from the other set, or any one or all shut off. From this distributing station for the water, the six pipes enter two tunnels, through which they are conveyed to the power house, three in each tunnel. The tunnels, one of which is now completed, are 13x10 ft. in size, with an arched and cemented roof, removing all danger from rocks falling on the pipes. The pipes increase in thickness as they go down, varying from 0.04 to 0.95 in., the inside diameter at the foot being 29 in. They are constructed in 30-ft. sections, with flanged ends, fastened outside, and offering no interior resistance to the water. From the entrance of the tunnel the pipes are horizontal for a distance of 191 ft., when they begin to fall at an angle of 36 deg., which in a short distance changes to 41 deg., at which angle they are brought to the side of the power house, where, at an elevation of 3,066 ft. above sea level, they are turned and carried to the individual turbine, at varying distances from this point.

The material for the power house, was transported down from the top of the first fall to the site at the base of the second in steel-framed cages, sliding on cables and operated by compressed air plants at the top of each. These cages are of considerable size, and are capable of carrying safely weights up to 15 tons, the largest single piece of machinery transported down having had that weight. There are two of these cages, one over each fall. At the foot of the first is located the temporary power house for the generation of the electricity and compressed air used in the construction work, and containing at present three 100-kw. generators, operated by horizontal turbines of 200 h.-p. each, and two large air compressors.

The main power house is a steel-framed structure, with rubble concrete foundation and wall, and ferroinclave roof. Sixty-five feet high above the floor line, 88 ft. wide and 198 ft. long, it gives ample room for six generators, with the transformers, switchboard and storeroom necessarily

provided for. The six feeder pipes pass below the main floor through the governing apparatus to the impulse waterwheels under the six generators, on the down-stream side of the building, passing under the transformers and switchboard.

The power is generated in six vertical units, operated by individual impulse waterwheels. The wheels are 100 in. in diameter, and carry 24 cast-steel buckets, against which the water from the pipes is thrown with a net static head of from 1,313 to 1,221 ft., according to the height at which the water stands in the reservoir above. The water is directed against the buckets from two nozzles, set diametrically opposite each other, an advantage of the vertically-set wheel over the horizontal system usually employed.

The two nozzles are $4\frac{1}{2}$ in. square when opened full, and are automatically regulated by oil governors, so joined that the openings of the valves of the nozzles are always equal in size. A safety valve allows for the escape of the water if the pressure gets beyond control and the wheel moves too fast. This safety valve is regulated by an oil switch directly connected with the oil bearings of the generator.

The waterwheel is bolted to a 14-in. shaft direct connected with the revolving field of the generator, both being designed for 300 r. p. m. The nozzles are opened by the oil system and closed by water pressure, so that, if the oil pres-



Laying Eight Cables at Once in the Harlem River, New York.

sure fails, the nozzles immediately close and shut off the water automatically. The system is started by a small impulse waterwheel, which starts the oil pump before the water is turned on, which, by the arrangement of the system, cannot take place until the oil pressure has reached a certain point. At 72 per cent. gate on the water pipe, each turbine and generator system will develop 5,800 h.-p., at 95 per cent. gate 7,500 h.-p., and at full gate 8,200 h.-p.

The generators are of the revolving field type, generating three-phase current at a periodicity of fifty cycles and a potential of 4,000 volts, and rated at 5,000 kw.

For the design and construction of the works connected with the enterprise, Dr. F. S. Pearson, consulting engineer of the company, has been responsible, and Mr. F. O. Blackwell has been associated with him in the electrical and hydraulic work. Mr. James Schuyler has been consulting engineer on the construction of the dams, and this work is being done from his plans. The entire construction department is under the direct management of Mr. Albert Carr. The operating department is under Mr. R. F. Hayward.

A Large Office Building.

One of the largest office buildings in the world will be formed by the completion of the Trinity Annex and the Trinity North Building, on which construction is now in progress in New York City. These buildings will virtually be an extension of the present Trinity Building, and will add 160 ft. to its Broadway front, inclusive of a 30-ft. passage left between them for Thames St. They will have a depth of 280 ft. to Trinity Place and will cover, with the present Trinity Building, an area of about 36,000 sq. ft. The architecture will conform to that of the Trinity Building, and the height will be about twenty-one stories above the street and two stories below it. The annex of the Trinity Building will exactly double the present size of that building and will extend over the former location of Thames St., which is moved $27\frac{1}{2}$ ft. parallel with itself and widened to 30 ft. Temple St., a narrow lane parallel to Broadway, will be abandoned and the area occupied by it will be exchanged by the city for an equal area given by the owners of the building to increase the widths of Thames and Cedar Sts. The construction will require 87 pneumatic caisson piers carried down through quicksand and hardpan to rock at a depth of about 83 ft. below the Broadway curb. The interior ones will have circular steel cylinders, and those

for the walls will have detached rectangular wooden caissons.

Mr. Francis Kimball is the architect for the building, the Geo. A. Fuller Co. are the general contractors, and the Foundation Co. are the contractors for the substructures.

Laying Eight Cables Simultaneously.

On May 12 there were laid in the Harlem River, just east of the New York Central & Hudson River R. R. bridge, nineteen cables, under the direction of Mr. W. H. Rodier, superintendent of construction of the Safety Insulated Wire & Cable Co., and Mr. J. D. Keiley, assistant electrical engineer of the railroad company. The power cables were manufactured by the Safety Insulated Wire & Cable Co., the telephone cables by the John A. Roebling Sons' Co., and the signal cables by the Okonite Co. Owing to the exceptional facilities of the Safety Insulated Wire & Cable Co., the armoring and finishing of cables in all cases was done at its works in Bayonne, N. J.

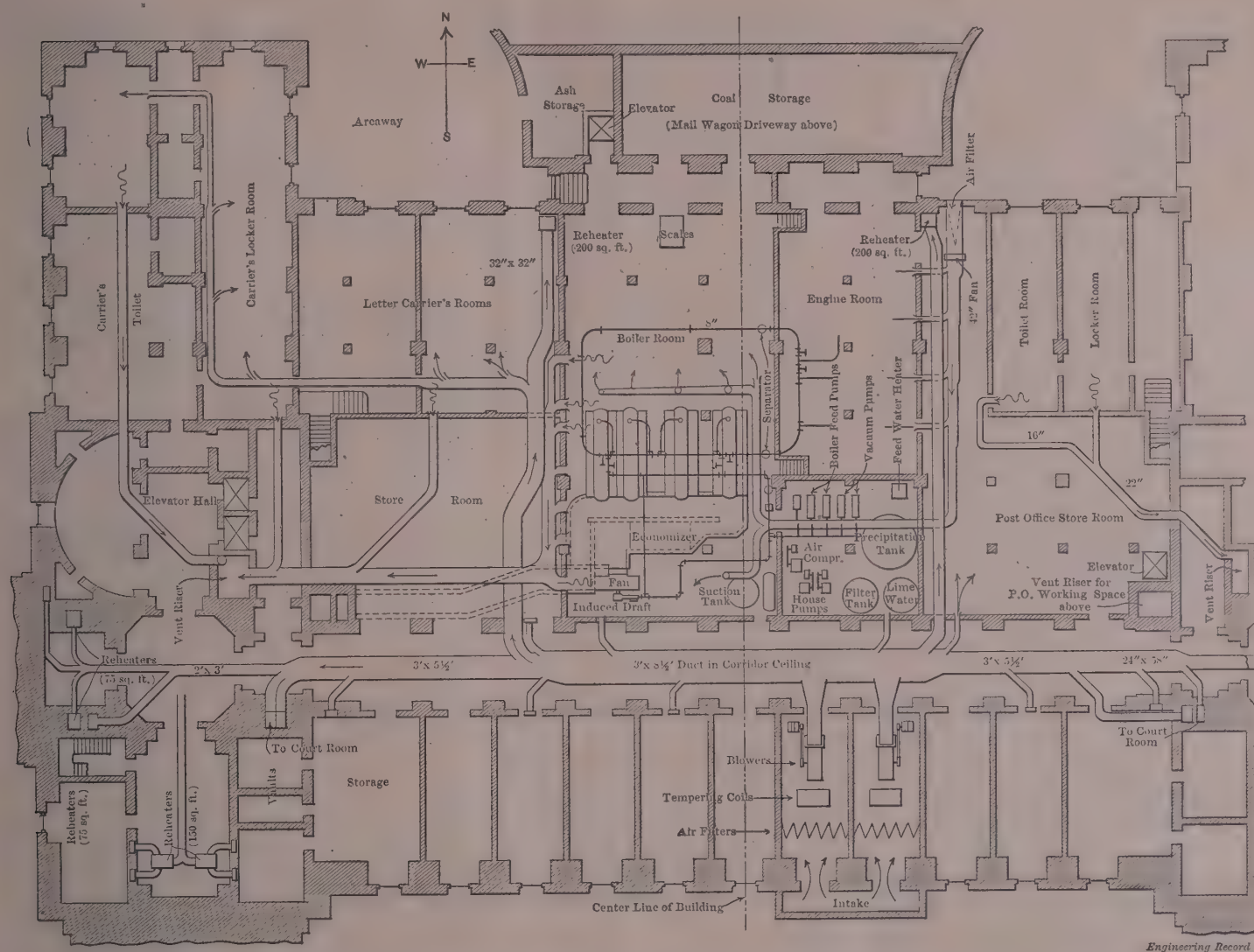
Heating and Ventilating Plant of the Indianapolis Post Office and Custom House.

The new United States Post Office and Custom House building at Indianapolis, Ind., is a large four-story and basement stone structure, built upon three sides of a hollow square, in the open court of which is a one-story and basement building with saw-tooth roof. The building which occupies an entire city block, is 215x335 ft. in size, with the interior court structure, 155x215 ft. in size, the latter accommodating upon the first floor the post office working space and in the basement the greater part of the mechanical plant, and store rooms in addition. There are main entrances at either front corner, the corridor arrangement involving elevator halls and ornamental semi-circular stairways in each of the side wings,

toms department and the secret service, while the fourth floor is occupied largely by dormitories, reading rooms and accommodations for clerks of the railway mail service.

The power plant occupies a space 85x100 ft. in the basement beneath the post office working section, with coal and ash storage provisions in a vault at the rear underneath the mail wagon driveway. The heating and ventilating plant is distinct from the latter, however, occupying two separate 18x45-ft. rooms across the hallway from the pump room, underneath the central portion of the front wing. Piping connections and heating and ventilating ducts are carried from these locations through all portions of the basement for connection to the various riser lines and flues, being concealed in the corridors and public portions by furred ceilings and elsewhere left exposed. The average height of the basement

capacity each, with Hawley down draft furnaces, and fuel economizers and induced draft equipment. The boilers are of the well known inclined type with wrought steel water legs of the Heine Safety Boiler Company, and are designed for operation at 130-lb. pressure. They have 36-in. by 20½-ft. steam drums delivering steam through 6-in. nozzles with internal steam separators, and each unit has 77 3½-in. tubes, 18 ft. in length, with a total effective boiler heating surface of 1,500 sq. ft. each. They have substantial brick settings with flush fronts and are fitted with the double-grate down draft furnaces of the Hawley Down Draft Furnace Company, Chicago, for the smokeless combustion of bituminous coal. The upper water-tube grates consist of 17 2-in. tubes, 5 ft. in length, and distributed for a grate width of 5 ft., while the regular grate equipment below, upon which coal from the upper grate falls when



Part Plan of Sub-basement Showing Mechanical Plant and Ventilating Apparatus.

with interconnecting main corridors or lobbies through the court side of the 60-ft. front wing upon each floor. The side wings are of similar width and have, for the greater part, 10 ft. center corridors with offices upon either side. The building is devoted to post office purposes exclusively upon the main floor with storage and supply rooms, clerks' and carriers' toilets and locker rooms and a bonded warehouse in the basement, the remainder of which is devoted to the boiler, engine and pump rooms, and a ventilating equipment. The entire second floor is devoted to two United States Courts, with a library, judges' rooms and accommodations for other officials and attaches, the third floor to the department of internal revenue, the pension department, the cus-

which is 6 ft. below grade, is 12 ft. under ceiling beams, but in the boiler room and coal vaults the floor is depressed an additional 6 ft. so that in the former a clear working head room of 18 ft. is obtained. The coal storage vault which is beneath an inclined runway from the adjacent street level up to a mail loading platform at the rear of the first floor post office section, has a clear height under beams of 14 ft. The location of the power plant is, such that no outside windows are possible for lighting and ventilation, but the latter is secured by an ample system of fresh air supply and exhaust ventilation connections.

Boiler Plant.—The steam generating equipment which is located in the 50x96-ft. boiler room, consists of four Heine water tube boilers of 150 h.p.

partly burned for completion of combustion, are plain grates of similar area of 25 sq. ft.; the lower grates are horizontal while the water tube grate is inclined with a pitch of 2½ in. per foot. The water tubes of the upper grate are expanded into an 8-in. pipe header at the front and a 10-in. header at the rear, the lower header having a 5-in. pipe connection from the rear water leg of the boiler, while the upper 10-in. header has a 6-in. pipe connection at one side of the setting up to the steam drum. The combustion space at the rear of the brick wall is covered by a heavy fire-brick arch which delivers the products of combustion to the boiler tube surface at the extreme rear, whence it makes two passes through the tubes to the breeching

connection. Coal is handled in barrows from the storage vault to the boilers, an easy incline from the coal vault to the boiler room floor permitting the coal to be trucked up without difficulty. The coal storage space is 25x77 ft. in size and has a capacity for about 400 tons of coal which is dumped into it through sidewalk coal holes through the driveway above. For the handling of ashes, there is an overhead trolley runway extending from the boiler fronts out into an ash storage room at one end of the bunker space. In this room there is a 5x6-ft. elevator for the hoisting of ashes to the driveway level for removal.

The products of combustion are removed by a chimney with a 5x6½-ft. flue, built into the wall at one corner of the interior court, which rises to a height of 102½ ft. above the boiler room floor. Connection is made to the boiler settings through an underground smoke duct, 5x6 ft. in section, and an interesting arrangement of smoke flues with economizers and induced draft fan equipment. The main smoke flue is an elevated fire-brick-lined brick duct, 4x6 ft. in cross section, carried horizontally across the boiler room at the rear of the settings, with a 2½x6-ft. dampered connection to each, and connecting at the west end to an induced draft fan. Paralleling this duct at the rear is an economizer setting which contains 24 tube sections of eight tubes each, the tubes being 4 in. in diameter and 9 ft. long, giving thus a total heating surface of 2,033 sq. ft. Connection from the smoke flue to the economizer is made at its easterly end by a dampered down connection, while at the chimney end, there is a dampered bypass connection leading direct to the chimney. Here the flue is fitted with a damper regulator and drops to the floor level to connect with an induced draft equipment, with bypass to the chimney underground flue. The flues are of brick with fire-brick lining throughout, being supported upon horizontal runs by T-bars spanning spaces between settings and supporting walls. The entire front of the economizer is of a removable metal construction, lined with asbestos, to permit of access to the economizer tubes. The latter are cleaned by a scraper equipment of the usual type which is driven by a 2-h.p. electric motor. The economizer equipment was furnished by the Green Fuel Economizer Company.

The induced draft equipment consists of a 120-in. blower, direct driven by a 8x10-in. horizontal steam engine, which is mounted at the rear of the economizer setting for a direct intake connection from the setting and delivery into the down connection of the smoke flue to the underground chimney duct. The blower has a 6-ft. fan wheel with blades 29 in. in width and at 285 r.p.m. has a capacity of 25,000 cu. ft. of gas per minute at a temperature of 500° F., which is equivalent to a draft in the main smoke header of the ¾ in. of water column. The fan is of the three-quarter housed steel-plate type with a single water-cooled bearing outside the casing. The engine is of the horizontal center crank type mounted upon an independent foundation, and is designed for operation at 80 lb. steam pressure. Both the blower and the engine were supplied by the American Blower Company.

The boilers are fed by two 7½x4½x6-in. Deane duplex pumps located in the adjoining pump room, 32 ft. square. They are proportioned for 140 lb. water pressure, with 80 lb. steam pressure, and of the outside-end-packed plunger type, brass fitted throughout for handling hot water. The feed is heated by a Webster open feed-water heater, receiver and purifier of 650 h.p. capacity, which is supplied with exhaust steam from the main exhaust line of the plant, and is fitted with an attached oil separator for removal of oil. The feed delivery system consists of a line of 3-in.

tin-lined brass pipe leading from the feed pumps through a trench into the boiler room to the economizer header and thence to a longitudinal 2½-in. feed header over the boiler fronts with a 2-in. feed connection to each boiler steam drum. Connection is made at the rear of the boilers to a hot water meter for measure of the feed, and both this meter and the economizer are fitted with bypasses for cutting out of service if desired. Each boiler has a 2-in. blow-off connection from the rear water leg and a 1½-in. surface blow connection taken from the front end of the steam drum, all of which connect to a 2-in. blow-off header located in the trench carrying the feed line at the rear of the boilers. The blow-off header is heavy wrought iron pipe with all turns of long radius bends, and discharges at the rear of the boiler room to a 42-in. x 12-ft. cylindrical blow-off tank. The blow-off tank has a 4-in. overflow to the sewer so located that the tank remains always partly filled and also a 5-in. vapor line which is joined by the vapor connection from the feed-water heater and is carried across to the vent flue beside the exhaust riser and thence up to the roof line. The blow-off tank has also a cooling coil for the purpose of cooling the blow-off discharge before entering the sewer, consisting of six lines of 3-in. galvanized pipe with return bends, extending the full length of the tank, presenting a total surface of 70 sq. ft.; through this coil is passed the cold water supply for the hot water house service tank and a considerable amount of heat thus reclaimed.

The plant has two systems of steam supply piping and another for exhaust steam, the first being a high pressure line to supply possible future generating units in the engine room and the second, a medium pressure line from which all steam pumps, the force draft engine and the live steam supplemental connection to the heating system are taken. The former high pressure main, is a ring main of heavy wrought iron piping with flange joints which encircles the boiler room and extends through Webster steam separators into the engine room, in which there are openings left for engine supply branches. This main is carried as a 10-in. header at the rear of the boiler settings, from which section two 6-in. outlet branches extend to the rear to supply the auxiliary medium-pressure header, and is continued as an 8-in. ring main to the engine room. The 6-in. boiler branches are made with long radius bends with a non-return stop check valve at the boiler nozzle and a gate valve at the header. The auxiliary header is a 6-in. line in the rear of the boiler room with a 2-in. branch to the induced draft fan engine, and is carried through a steam separator and Kieley pressure-reducing-valve to the pump room for the supply of the pumps at a reduced pressure. The latter has 1½-in. connections to the two boiler feed pumps, 1¼-in. connections to each of two vacuum pumps and a 5-in. connection through a Kieley pressure-reducing-valve, with bypass, to the low-pressure heating main. The pressure-reducing-valve delivery to the pump room is adjusted to deliver at 80 lb., and is bypassed for direct supply if necessary. A second 2-in. steam connection has also been made from the pump room header direct to the induced draft engine enabling it to be operated either at boiler or reduced pressure. The high pressure piping is dripped by three separate drip lines, one serving the three steam separators and drip pockets beneath the engine branch connections in the engine room, another dripping the 10-in. section of the ring main above the boilers and the third the medium pressure header in the pump room; each of these delivers to a Kieley steam trap in the pump room which are connected to discharge into the feed water heater. The pump cylinder drips, and the drip connections from all engine cylinders, oil separat-

or and exhaust lines, are discharged into a 42x42-in. by 8-ft. drip tank, in the boiler room, in which there is also a cooling coil of 3-in. pipe for cooling the condensation returned to it.

Water Supply.—The water supply of the plant consists of a 4-in. connection to the street mains of the city system and two artesian wells driven in the rear portion of the pump room which are together capable of supplying 200 gal. of water per minute. The latter are depended upon almost entirely, the former being installed principally for purposes of reserve, and as hard water is obtained from the wells, a water softening plant capable of softening 3,000 gal. of water per hour has been installed for the preparation of the boiler feed water supply. The two wells are driven at points about 15 ft. apart in the rear of the pump room and are 8-in. wells driven down about 300 ft. below the surface, with casings carried down to solid rock. Each well is pumped by an American air lift of capacity of 100 gal. per minute and delivers into a 5x5x11-ft. open discharge tank, elevated to the ceiling of the pump room for gravity supply to the purification tanks. Compressed air for the air lifts is supplied at 100 lb. by an 8x10 horizontal air compressor belt-driven by a 25-h.p. direct-current electric motor. The pump is water jacketed and delivers through a 3-in. line to a 30-in. by 6-ft. cylindrical storage tank from which 2-in. air supply lines are carried to each air lift. The operation of the air lifts is entirely automatic, a float valve in the elevated discharge tank setting them into operation as necessary to replenish.

The water softening plant consists of a lime slaker, a lime water tank, a precipitation tank and a water filter, all located in the pump room, and a suction well which is located in the rear corner of the boiler room. The lime water tank is a vertical cylindrical tank of concrete construction 7 ft. in diameter by 11 ft. high, above which is located the lime slaker, a 3x4-ft. tank 15 in. deep, in which milk of lime is prepared for the softening process. The lime water is prepared by a continuous mixing of the milk of lime with purified water delivered from the house service to the lime water tank, from which it is delivered to the precipitation tank for the softening action upon the well water. The precipitation tank is similarly of concrete construction, 12 ft. in diameter by 12 ft. high, and upon it is supported the air-lift discharge tank. The arrangement of connections is such that as water is required in the plant it flows from the air-lift discharge tank to the precipitation tank, where lime water is added in a predetermined proportion for the softening process. The size of the precipitation tank and circuit of flow is such as to permit of a very slow movement of the water through it to facilitate the precipitation of the insoluble impurities which are thrown down. The action of the softening plant apparatus is entirely automatic, the flow of well water to the precipitation tank being controlled by a float in the filter tank. The latter tank is a third open cylindrical tank of concrete construction, 7 ft. in diameter by 6 ft. high, with mechanical agitator which frees the water of precipitated sludge before entering the suction well for boiler feeding and the house service. The filter agitator is driven by a 3-h.p. direct-current motor, which drives through bevel gearing. There is a by-pass connection from the precipitation tank direct to the suction well so that water may be delivered to the latter without filtering if necessary. The latter is a concrete tank in the boiler room floor, 7 ft. in diameter by 7 ft. deep, in which water is maintained at a depth of 6 ft. by a float valve in the delivery pipe.

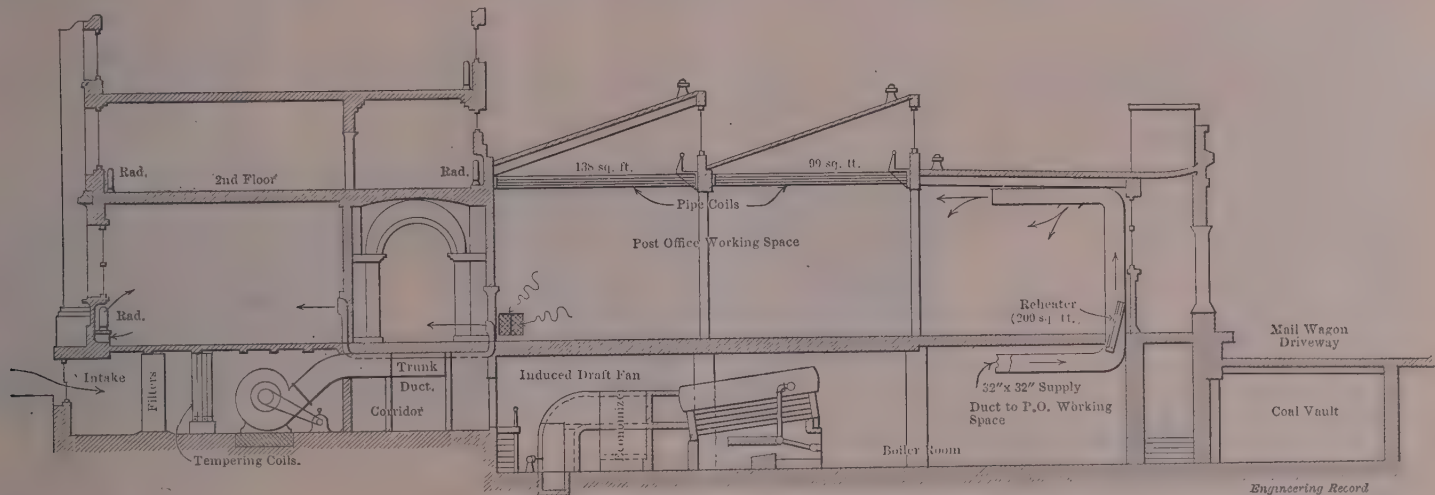
The house water service is supplied by two 5x8 Gould's vertical triplex single acting pumps with outside packed plungers, which are belt driven by 20 h.p. direct-current motors, and deliver to four 7½x18-ft. supply tanks, each 5 ft. high, located in

the attic at each end of the building near the elevator shafts. The pump motors are controlled automatically by floats in these roof tanks with electrical connections for the operation of the motor starters in the pump room. The pumps deliver to the roof tanks by a 4-in. main riser which enters the latter below the water line, and from this riser are taken off the connections to the feed pumps and house service in the basement as required. The hot water service is furnished by a 36-in. by 10-ft. hot water generator, the heating coil of which consists of a series of U-shaped brass tubes presenting one square foot of heating surface to each twelve gallons of capacity of the tank, through which steam is circulated under automatic control by a temperature regulator valve. The water supply to the hot water generator is through the 3-in. line from the cooling coils of the drip and blow-off tanks, so that all water for the hot water system is partially heated before entering the generator.

An engine room, 32x62 ft. in size, has been provided alongside of the boiler room for the accommodation of future electrical generating equipment if it should be desired to generate the electrical supply upon the premises. The high-pressure ring steam supply main is carried into this room and blanked openings left for engine branches, and also all drip connections, and an exhaust main in a trench in the floor. The elec-

Direct radiation is provided in all rooms of the building above the basement and in all outer basement rooms, in varying amounts of surface depending upon the size of the room, exposure and proportion of indirect heating supplied. The radiators used are for the greater part of the two column type, of the American Radiator Co.'s manufacture, 38 in. high, although of varying heights upon the lower floors. They are generally located under window sills and, except in the public portions of the post office section and in the court rooms, are under hand control. Upon the main floor, where considerable amounts of indirect radiation are supplied, radiation is provided in the proportion of one square foot of heating surface to 80 cu. ft. of interior volume. In the court rooms this proportion is increased to 1 sq. ft. per 40 cu. ft., owing to the lesser capacity of the indirect system supply, and to permit of ample heating without the indirect system. In the remaining portions of the upper floors which have indirect supply, the proportion varies from 1 to 70 up to 1 to 40, according to the requirements of occupation and to the exterior exposure. In the post office working space, the single-story section in the interior court with sawtooth roof, the proportion is only 1 to 200, the greater part of the heating being accomplished by the indirect system; here skylight coils are provided in the proportions of 400 sq. ft. of heating surface

risers are supplied at points around the exterior walls, between all vertical lines of windows from which short direct connections were possible to radiators. The majority of the risers are of 1¼ and 1½-in. piping, the largest being 2 in. The risers are all rigidly anchored at the second floor level, from which free expansion is provided for above and below. All radiators have ½-in. return connections, eccentrically tapped, which returns are made through Webster automatic air and water relief valves to the vacuum return system. The supply risers and branch connections are in all cases paralleled by return lines which lead to a main return line in the basement connecting to the vacuum pumps. Drip pockets at the lower ends of the supply risers and from the heating main are also connected through Webster automatic air and water relief valves to the return main for removal of condensation. There are two vacuum return pumps, each National Foundry & Machine Co. single-acting, brass fitted steam pumps, either one of which is capable of handling the returns of the entire building. The vacuum pumps discharge into a Webster vacuum feed water heater through an air separating loop for freeing the condensation returned of air. The loop consists of a vertical section of 8-in. pipe connected into the delivery line with an opening at the top connected by a 1½-in. line to the blow-off tank vapor riser.



Part Section Through Center of Building to Show Arrangement of Ventilating Equipment.

trical current supply will, however, for the present be purchased from the Indianapolis Light & Power Co.

Heating and Ventilating.—The building is heated throughout by direct radiation, which is supplemented in the vestibules, in the working space and public portions of the post office department, in the court rooms and other public departments by indirect radiation. Exhaust steam from the engines and pumps is utilized in the heating apparatus without appreciable back pressure on the engines or pumps by means of the Webster system of steam circulation, live steam being admitted through an automatic pressure-reducing valve when the exhaust steam supply is insufficient. All radiation of the indirect systems and that concerned with the heating of public rooms is equipped with automatic temperature control. A feature of the system is the use of reheaters in the long duct lines supplying the vestibules and the post office working space, for the supply of air at increased temperatures in exposed portions. There is also a fresh air supply system without heating coils for the ventilation of the boiler and pump rooms. Exhaust ventilation is provided for the mechanical plant, post office, working section, and the public rooms of the building, which is operated by a number of exhaust fans in the attic.

for each continuous line of sash, which is 8 ft. in height and 200 ft. long. This skylight radiation consists of return bend coils of 1¼-in. pipe, which is carried beneath the window sash and across the ends of the sawtooth monitors. A special heating equipment consists of two thawing coils arranged beneath the roof gutters upon the front of the building for the thawing of snow and ice in winter; each coil involves a return bend of 1½-in. pipe presenting 100 sq. ft. of surface each, which are controlled from valves in the basement. The design of the heating system as laid out provides for maintaining a uniform temperature in the building at from 70° to 75° F. throughout zero weather.

All radiation, both direct and indirect, is operated upon the two-pipe system, the low-pressure supply originating in the exhaust steam system of the power plant, with live steam supplemental connection, while the returns are operated by the Webster system through vacuum pumps in the pump room which return the condensation to the boiler-feed system. The heating main consists of a 12-in. line connecting through an oil separator to the exhaust main in the pump room which distributes to radiation in the building through four main branch lines, two of 5-in. piping to the northeast and northwest sections and two of 6-in. pipe to the two front corner sections. From these

The indirect heating equipment consists of a system of delivery ducts in the basement and two blower and heating coil equipments in duplicate, either of which is capable of supplying the system. The two blower equipments are, as above stated, located in independent basement rooms beneath the front wing, and each comprises a window fresh air intake, an air filter, a heating coil and a motor-driven blower, which delivers through a dampered supply connection, 42 in. square, to the trunk distribution duct of the system. The latter is a rectangular duct of No. 20 galvanized iron, concealed above the furred ceiling of the basement corridor, and is 3x8 ft. in section through the central portion of the corridor, decreasing as branches are taken off, first to 3x5½ ft. in section, and beyond to 24x42 in. From the trunk duct two large branches are taken off to the rear, one 32 in. square supplying one side of the post office working space above and the other, a 32x54-in. duct with a branch 32 in. square to supply the other side of the working space above and a 24x30-in. branch supplying a number of rooms in the basement floor, including the carriers' locker, toilet and recreation rooms. There are supply connections upon the main floor to the entrance vestibules and to the public portions of the post office section in addition to the working space. Upon the second floor indirect supply

is provided in the two court rooms; upon the third floor, in the pension department in the front wing, and upon the fourth floor, in the reading rooms, dormitories and other rooms of the railway mail service. The riser flues are in nearly all cases run in chases, the supply branches in the basement being made under furred ceilings. The duct work is of No. 24 and No. 20 gauges, the latter for ducts wider than 40 in., and branches which are in all cases made with long radius bends, have deflector dampers in the branch openings from the trunk duct to enable full pressure to be obtained in the branch ducts and also permit of adjustments of pressure in them. Registers are for the greater part located at distances from 7 to 10 ft. above the floor line excepting in certain of the corridors, where they are located very close to the floor. The design of the system provides for average velocities of flow in duct work of 150 ft. per min., decreasing slightly in branches at register outlets.

The fans for the indirect supply are each full housed steel-plate blowers, with 6-ft. wheels 35 in. wide, and have double intakes from the air chamber rooms in which they are located, delivering to the trunk duct by delivery connections 42 in. square. Each blower is belt driven by an individual motor of 10-h.-p. capacity, and operating at 220 r. p. m., has a capacity of 30,000 cu. ft. per min. The air is preheated by tempering coils at the rear, between the blower and the air filter, which consist of pipe coil stacks of six sections each, presenting a total heating surface of 1,690 sq. ft. Each of the six sections has two rows of 36-9 ft. vertical pipes, fitted into independent cast iron bases, and are supplied in two three-section groups, each with a Johnson thermostatic control valve operated from thermostats in the cold air intake, and with a Webster automatic air and water relief valve in the return connection. The design of this equipment is to maintain the temperature of air delivered at from 70 to 75° in zero weather. The blowers and the heating coils were supplied by the American Blower Company.

The air filters are of the cheesecloth type, located at the rear near the window intakes, and consist of cheesecloth covered frames 3x11½ ft. in size, which are mounted in zigzag order upon angle iron supporting frames in order to secure a maximum filtering area. The frames are of light wooden construction, consisting of 2½x3¾-in. yellow pine frames, the filtering medium being mounted by ¾x1¼-in. oak cleats, which are clamped in place by thumb screws. The cheesecloth is backed up by poultry wire netting, and there are duplicate panels provided for exchange in cleaning. The total surface of filtering medium presented is 350 sq. ft., so that with the fan operating at a maximum capacity, the filtering velocity does not exceed 60 ft. per minute.

A feature of the indirect supply to the vestibule spaces of the main floor corridors and to the post office working space, is the provision of reheaters near the points of delivery for raising the temperature at delivery to counteract in the former cases the influx of cold air from the entrances, and in the latter that due to the frequent opening of doors at the mail loading platform at the rear. At each of the front entrances there are two supply ducts upon either side, each 8x20-in. risers discharging through 20x30-in. outlet registers in the vestibules. The supply to these risers are each taken from the main duct through a 14x16-in. branch passing first to a box coil containing 150 sq. ft. of heating surface for supplementary heating when desired. The end entrances have each a single register 20 in. square upon either side, which is supplied by a 10x20-in. riser flue; each of these connections has a box coil in the basement with 75 sq. ft. of heating surface for similar supplementary heating. These

supplementary heaters consist of cast iron bases with 1-in. piping mounted vertically, and are supplied in two sections with hand control. The two supply ducts to the post office working space are fitted with box coils having 200 sq. ft. of surface each, which are here built up of return bends of 1-in. pipe arranged four rows deep upon cast iron bases and hung inclined in the 36x45-in. riser ducts from the basement to the discharge outlets. They are also fitted with hand control, and are intended for use in severe weather only to supplement the main indirect heating system.

Ventilation is provided for the mechanical plant in the basement, and in the letter carriers' locker and recreation rooms adjoining, in the post office working space on the main floor, for the court rooms upon the second floor, and in the front rooms upon the fourth floor. This is accomplished by a group of six disc exhaust fans located in the attic, four of which are 48-in. fans and two 36-in. fans, all direct driven by electric motors. One of the 48-in. fans on the west side serves the greater portion of the basement through a 7x10-ft. vent riser, from which a 37x42-in. branch leads to the boiler room, with seven 8x30-in. vent registers located at the ceiling upon the west side; this vent riser also serves a number of vent registers in the letter carriers' department adjoining. Through this riser is car-

A Temporary Wooden Drawbridge.

A number of temporary wooden bridges, with draw spans of an unusual type, have been erected by the city of Chicago over the North and South branches of the Chicago River during the past year. These bridges have been built to carry highway and street railway traffic pending the completion of permanent bascule bridges. The temporary bridge over the North branch of the river at North Ave. is the one most recently erected, and embodies a number of improvements on any of the previous structures. The branch of the river at this crossing carries a heavy traffic from the numerous elevators and factories along its banks. North Ave. is one of the principal cross-town streets on the north side of the city, and carries a large amount of highway traffic and the traffic on an important double-track street car line. The stream has a clear width of 195 ft. between dock lines at the crossing, and was formerly spanned by a wooden-truss drawbridge of a primitive type, which had a center pier. This old bridge was in bad condition and the center pier interfered greatly with the river traffic. The contracts were awarded for the erection of a bascule bridge of the trunnion type, but the old structure on the site was so badly worn out



View of Temporary Wooden Drawbridge over Chicago River.

ried a 24-in. cylindrical duct from the letter carriers' and clerks' toilet rooms at the rear corner of the basement up to an individual 36-in. fan in the attic; this fan has an independent discharge outlet in the penthouse in order to keep the two systems entirely separate. This fan, and also a similar 36-in. fan upon the east side of the attic, also exhaust from toilet room vent risers upon the respective sides of the building which lead from the toilet rooms near the elevator shafts at either end of the main corridor. The post office working space is ventilated by two riser ducts, one at either front corner, that upon the east side leading to a 48-in. fan in the attic, and the other upon the west side running up alongside of the chimney and thus operated by natural draft. The remaining 48-in. fans in the attic have duct connections to the various vent risers in the walls, from the court rooms and auxiliary rooms upon the third and fourth floors, which are served with exhaust ventilation. The engine room ventilation involves, in addition to the exhaust connections, a cold fresh air supply consisting of a 42-in. fan with intake through a basement window at the rear delivering through a conical air filter to a system of duct work with branches to all portions of the engine, boiler and pump room.

The entire mechanical and electrical installation, including power plant, water supply, heating and ventilating systems and lighting equipment, has been installed by Jos. McWilliams & Co., Louisville, Ky. The architects for the building were Rankin & Kellogg, Philadelphia, Pa.

that it could not be moved. It was, therefore, wrecked and the temporary structure built a short distance downstream from the site, and will be used until the new bridge is completed.

The temporary bridge has a total length of practically 700 ft. and is 90 ft. downstream from the site of the new bridge. It embraces a 100-ft. draw span and a long trestle approach on pile and timber bents at each end of the draw. The bridge carries a 21-ft. roadway and the two street-car tracks, with a walk 5 ft. wide, on one side. The draw span provides a clear channel 70 ft. wide when open. One corner of one end of this span is pivoted on a heavy timber frame built up on piles at the end of the trestle approach to that end of the draw span. The pivot consists of a hemispherical steel casting, with a 6-in. radius, and is bolted to the under side of a heavy bolster placed transversely under the lower chords of the bridge. The pivot rests in a heavy cast-steel socket on the timber frame on the piles. A 22-in. wheel, with a 9-in. face, is placed under the other corner on the same end of the bridge. This wheel is attached to the other end of the bolster carrying the pivot and travels on a track made of steel plates, which are laid to a radius of 21 ft. on the frame carrying the socket of the pivot. A 15x40.5-ft. scow, which serves as a pontoon, is placed transversely under the draw span, 16 ft. from the other end, and carries all of the load on that end when the draw is open and part of the load of the draw at all times. The scow

carries water ballast, which may be increased or decreased, and when the draw is closed the weight is partially transferred from the scow to a timber bridge-seat on piles at the end of the approach on that side of the stream. The draw is opened and closed by an electrically-driven paddle wheel on the scow, which moves the latter in the arc of a circle, with the pivoted corner of the span as a center.

A general cross-section, a longitudinal elevation and the details of the wheel and pivot on the draw span are shown in the accompanying illustrations. The chords, floor beams, posts and cross pieces are Oregon fir. Each rail of the street car tracks is carried by a 10x10-in. pine stringer. The roadway is floored with 4-in. white oak planking. The trestle approaches to the draw span are on pile bents outside the dock lines and on timber bents on mud sills back of the dock line. The bents are spaced 10 ft. apart on centers, and are thoroughly cross-braced and X-braced.

The draw is operated by electric motors, controlled from a switchboard in a bridge-tender's house at the floating end of the span. The floating end is locked in position, when the

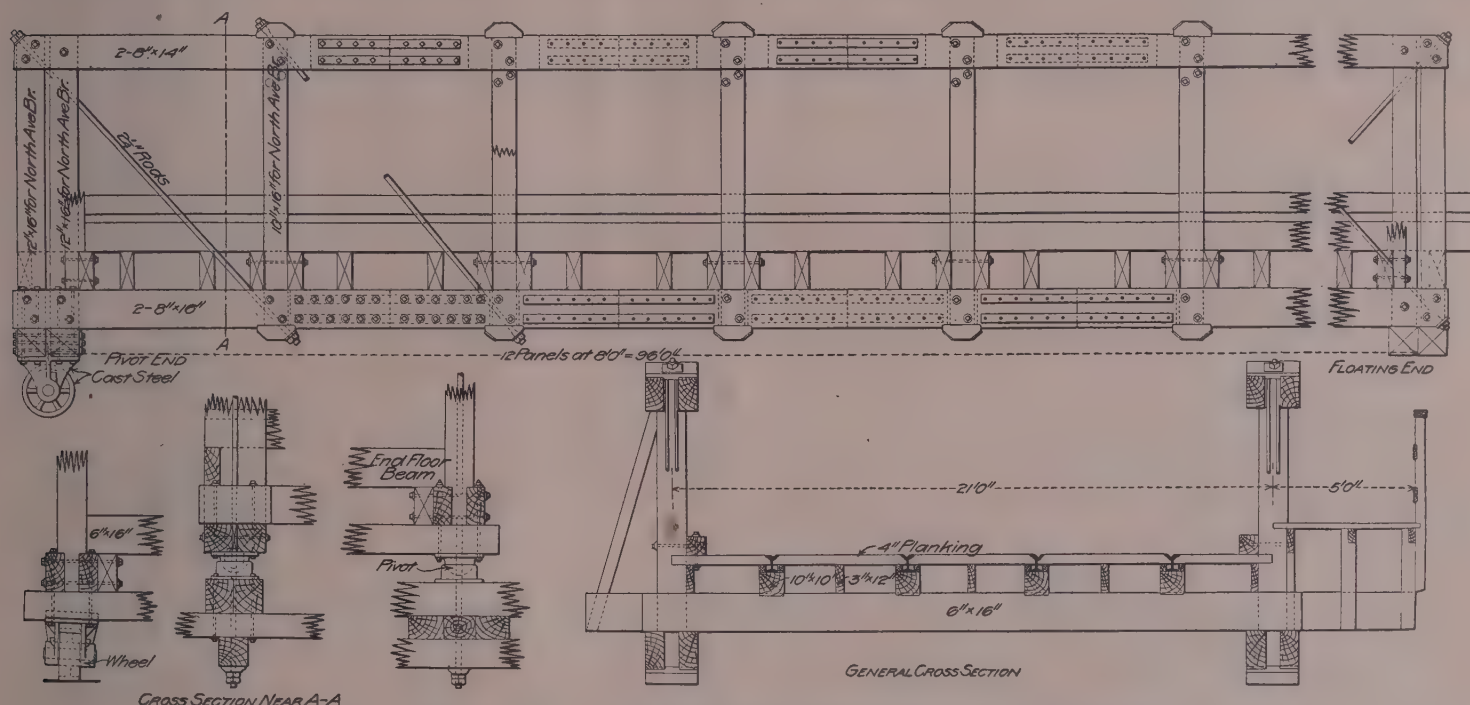
the direction and intensity of the wind. The longitudinal center line of the bridge is east and west and the lowest water conditions exist with a wind directly from the north. Provision has been made to permit the scow to rise and fall with the water level in the stream, in order to insure a sufficient draft for the effective operation of the paddle wheel. The floating end of the draw span is, for that reason, carried on the scow by four heavy screws, two on each side toward the ends of the scow. These screws are each worm-gear to a sprocket wheel and the four sprockets are driven by a single 10-h.-p. General Electric motor at the center of the partial floor above the bottom of the scow. This motor is also controlled from the switchboard in the bridge tender's house. Under the most extreme conditions of north wind and low water the draw closes slowly, but the paddle wheel has always furnished sufficient power to propel the scow and open and close the bridge under all circumstances. With normal, or even ordinarily low-water and contrary wind conditions, the draw is readily closed and opened with the paddle wheel in about a minute. The weight of the draw span is about 100

An Instructive Test of Mild Steel.

Mr. Robert A. Hadfield, in the annual James Forrest lecture before the Institution of Civil Engineers last month, described a test and gave some conclusions based on it that deserve consideration. Mild steel of best quality, containing C. 0.12 per cent., Si. 0.02 per cent., S. 0.02 per cent., P. 0.02 per cent., Mn. 0.28 per cent., was obtained; this in its properly prepared condition possessed an elastic limit of 16 tons per square inch, a tenacity of 28 tons per square inch, an elongation of 35 per cent., and a reduction in area of 65 per cent. Under the notch or nicked test this bent double cold.

Portions of the same steel were heated to about 1200 deg. Cent., and allowed to cool slowly. The results were as follows: Elastic limit, 9 tons per square inch; tenacity, 22 tons per square inch; elongation, 46 per cent.; reduction in area, 64 per cent.

It would naturally be assumed, with a rise of 10 per cent. in elongation—that is, to the high figure of 46 per cent.—and the excellent reduction



Details of Construction of Temporary Wooden Drawbridge over Chicago River.

draw is closed, by a hinged drop-block which fits in a groove in the bridge seat. This block may be raised by a rope leading to the tender's house when the draw is to be opened. Enough of the water ballast is then pumped out of the scow by a motor-driven centrifugal pump submerged in the latter, to raise the floating end of the span from the bridge seat. This pump is geared through a vertical shaft to a 5-h.-p. General Electric direct-current motor, which is set on a partial floor 5 ft. above the bottom of the scow, and is controlled from the switchboard in the tender's house. When the floating end of the span has been raised sufficiently from the bridge seat, the motor driving the paddle wheel is started and the floating end swung around on the scow, the fixed end turning on the pivot and wheel. The draw is closed by reversing the paddle wheel. When the floating end of the draw is again in position over its bridge seat, a sea cock is opened in the side of the scow and water ballast admitted to the latter until the end of the span takes bearing on the bridge seat again.

The level of the water in the stream varies as much as 3 ft., owing to the variation of the height of the water in Lake Michigan and to

tons, of which 65 tons are carried by the scow and the remainder by the pivot and wheel.

The other temporary bridges of the same type that have been built are equipped with an electrically-driven double drum carrying two chains, with their outer ends anchored on the shore. These temporary bridges have all been designed and erected under the direction of Mr. Thomas G. Pihlfeldt, city bridge engineer, of Chicago. The North Ave. temporary bridge was erected by Jackson & Corbett, of Chicago, and the substructure work on the permanent bridge at that crossing is also being carried on by the same contractors. The contract for the erection of the superstructure of the permanent bridge has been awarded to the firm of Roemheld & Gallery, of Chicago.

BITULITHIC PAVEMENT has proved satisfactory in Springfield, Mass., according to the 1905 report of the Superintendent of Streets and Sewers. There have been a few complaints of dust from its surface when recently laid, but care in watering, and wear enough to take off the fine rock dust which was rolled into the surface have done away with this slight annoyance.

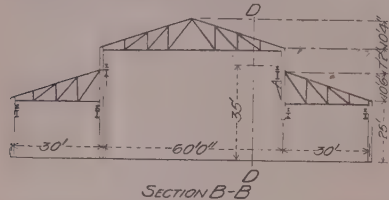
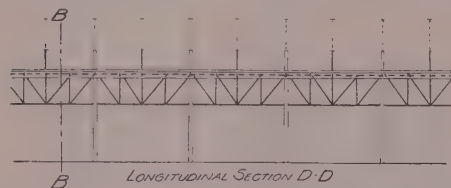
in area of 64 per cent., that the material would be in a still better condition to resist shock than the original specimen, but under the dynamic shock or notch test, remarkable to say, it snapped like cast iron, not even bending 1 deg. Yet a test-piece of the same size and from the same material not nicked bent double cold under shock. This is a most curious result, and shows, Mr. Hadfield said, how careful users of steel should be in its heat treatment, as, without doubt, brittleness can be developed, under certain conditions, at much lower temperatures than the one above mentioned. It is also clearly seen that the existence of the bad qualities, brittleness and low resistance to shock tests, are not shown by the use of ordinary tensile tests. There is no doubt that careless and improper heat treatment, either originally by the maker, or afterwards by the user, are largely accountable for most of the so-called mysterious failures of boiler-plate and other steel for structural purposes, and yet the existence of the defects or peculiar brittle structure is not detected by the usual tensile tests.

THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS will meet at Brussels Sept. 3 to 8.

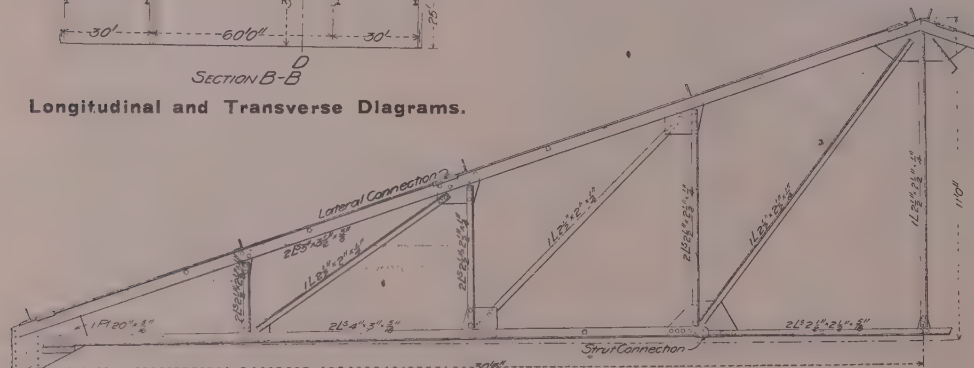
The Construction of the Lidgerwood Plant at Waverly, N. J.

The new plant of the Lidgerwood Manufacturing Co., New York, is located at Waverly, N. J., where a twelve-acre site has been secured, and buildings costing about \$500,000 are being erected for the manufacture of hoisting engines, cableways, and other plant in which the company deals. The site is adjacent to the tracks of the Pennsylvania and Lehigh Valley railroads, branches from which will traverse the property and afford direct connection to all of the principal buildings. These will include a 550x120-ft. foundry, a power house, a 780x120-ft. erecting shop with six 250-ft. wings for light and heavy tools, shipping house and carpenter, boiler maker and blacksmith shops. Part of the buildings will be of reinforced concrete, and part of them will have steel frameworks and brick walls. The foundry, power house, reinforced concrete pattern shop and some minor wooden buildings have already been erected and the remainder will be built in the near future.

The ground occupied by the site was formerly a swamp which has been filled 6 or 8 ft. with ashes and other city refuse to a level 4 or 5 ft. above water line. In the center of each building



Longitudinal and Transverse Diagrams.



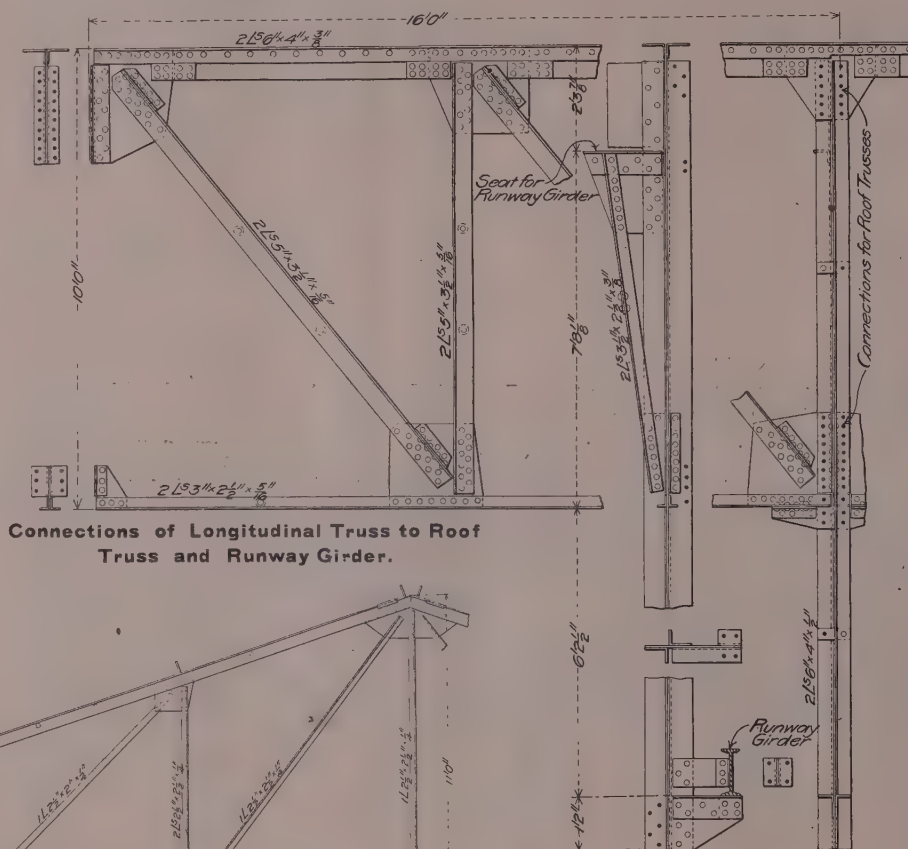
Main Aisle Roof Truss.

a 6x6-in. post 10 ft. long was driven and a nail was driven in the upper end to mark the intersection of the longitudinal and transverse axes, and serve as a bench mark for accurate levels. Similar posts were lined in 600 ft. away in both axes of the building and from them all lines, measurements and levels were first established, being transferred to the concrete piers after the latter were built. On account of the loose character of the soil, preparations were made for building the foundations before the other construction was commenced so as to allow for final settlement before they were loaded with the superstructure.

As the lower floors of the buildings are above the present surface of the ground no general excavations were required. The fill contained a great deal of miscellaneous matter and was sufficiently solid to stand in vertical banks without sheeting. Pits were dug about 7 ft. deep and were drained by Edson diaphragm pumps operated by hand. As soon as each pit was completed foundation piles from 25 to 35 ft. long were driven in it with a penetration of 18 or

20 ft. below the bottom of the pit and a minimum refusal of 1½ in. for a 2,000-lb. hammer falling 15 ft. They were chopped off to a convenient height and then sawed square one foot below the water line.

A permanent rectangular wooden frame or coffer dam was set in the pit enclosing the pile tops and was filled with concrete mixed comparatively dry. A knock-down form was set up on this footing and a 3-in. layer of concrete deposited in the bottom, then a full-size sheet of expanded metal was laid on the surface and the remainder of the concrete was rammed in to fill the form. Before the concrete was deposited anchor bolts were lined in with a transit and carefully secured by templates nailed to the forms. The concrete was made 1:3:6 with Atlas Portland cement, hand mixed, and



Connections of Longitudinal Truss to Roof Truss and Runway Girder.

ft. wide and 548 ft. long on centers of columns. It has 35 sets of transverse roof trusses supported on four longitudinal rows of columns 30 and 60 ft. from the center line. The wall columns are 16 ft. apart and those in the interior rows are 32 ft. apart, thus making double-length panels between the interior columns. The sets of roof trusses are all alike, but those in the interior column bents are carried directly by the latter while the alternate ones are carried by longitudinal trusses connecting the tops of the interior columns. These longitudinal trusses together with the outer brick walls and the roof sheathing give the building considerable rigidity, which is supplemented by two intermediate panels of X-brace lateral rods in the planes of the top and bottom chords of the roof trusses.

Near the middle of the building there are,

in one side aisle, three cupolas with a 50x30-ft. charging floor 18 ft. above the main floor, which is proportioned for a load of 700 lb. per square foot. The floor consists of solid ½-in. steel plates supported on transverse 15-in. I-beams 4 ft. apart and 15 ft. long, carried by 20-in. I-beams at the ends and on a plate girder in the center of the floor. Coal and iron are delivered to this platform by two elevators in an outside steel tower.

The 60-ft. middle aisle of the building is served by a 15-ton traveling electric girder crane and the side aisles are provided with runways and 2½-ton cranes.

The construction of the steel work is simple and regular, securing a very light framework with many duplicate members advantageously built in the shops and provided with connections adapted to easy erection. All of the columns were of the ordinary I-shaped cross-section, made with two angles in each flange. Each of those for the center aisle carries two panel loads of roof trusses and crane girders and is made, as shown in the illustration, with a solid web up to the level of the crane runway, where the girders are seated on horizontal cap plates with their center lines nearly over the flange angles of the column. At this level the main column flanges terminate and lighter angles are riveted to con-

although much of it was laid at a rising temperature of 28° none of it was frozen before setting.

After the piers had set for a long time connecting beams of reinforced concrete were built between them to carry the walls of the building clear of the surface of the ground. They were made in movable forms which were transferred from panel to panel for the construction of the successive spans. After the concrete was built, the space between the piers was filled in with 40,000 cu. yd. of good earth covering the refuse in the original fill and delivered by wagons and railroad cars on a track through the center of the building. The substructure contained about 2,500 cu. yd. of concrete and was built by a maximum force of about 40 men, subject to many delays by bad winter weather.

The construction of the superstructure was commenced in February of this year by building several small wooden houses ultimately designed for the storage of coal, coke, etc., but utilized first as a temporary office and store rooms. The first building erected was the steel foundry 120

tinued the column to the roof truss, the web plate between them being replaced by lattice bars. The longitudinal girders connecting the columns are riveted Pratt trusses made with pairs of angles back to back, except the top chords, which have T-shaped cross-sections with an 8x5/16-in. web plate. They were field-riveted to the columns through their end vertical angles and in the center of each there is securely riveted a vertical strut composed of two 6x4x1/2-in. angles 17 ft. long which project 7 1/2 ft. below the lower chord to support the I-beams for the girders for the 2 1/2-ton cranes. The intermediate roof trusses in the center aisle have horizontal shoes seated on the top chords of the longitudinal trusses.

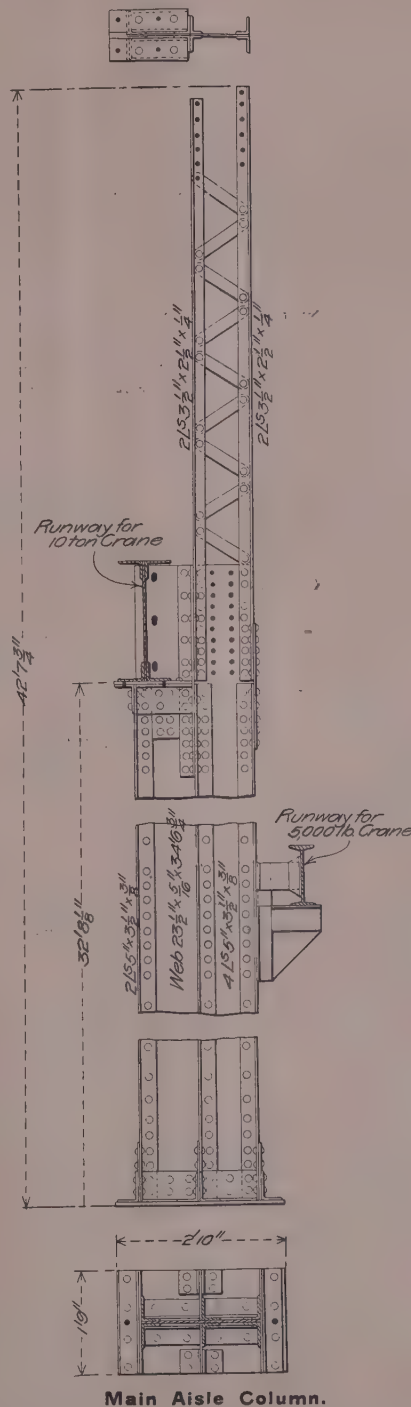
The main roof trusses are of very light construction, made as shown in the elevation, with pairs of angles for the top and bottom chords and vertical and single angles for the diagonals. They were shipped completely riveted from the shops. The roof trusses over the side aisles are of similar construction, but their connections to the center aisle columns are field-riveted through the outstanding flanges of short vertical angles. At the outer ends the gusset plates connecting the top and bottom chord angles project beyond the latter to engage the flange angles of the wall columns and really make the upper part of the column web, thus providing integral construction for the column and roof trusses and serving as a kneebrace between the two members. The main roof trusses weigh about 1,200 lb. each and the total weight of steel in the building is about 600 tons.

Before commencing construction the contractors provided a complete set of working drawings of all parts of the buildings for use in the field. These included descriptions of all of the brickwork, specially arranged for the convenience of the foreman and masons at the site, together with complete sets of drawings for all of the doors, windows, cornice and other details which left no measurements or details to be determined in the field and very much facilitated economy and rapidity of the work. Special distribution plans were also provided on which were located the quantities of materials required, so that each piece of steel was delivered and stored exactly as marked, and required no handling or assortment, except to unload pieces and afterwards to pick them up for erection. Specified quantities of lumber and brick were located in the same manner so that just enough of these materials were delivered at a given point to serve the workmen in that vicinity.

With these provisions and on account of the care exercised in designing the work and details it was possible to erect the foundry building in a remarkably short time. The steel framework was assembled by 30 men in 9 days 6 3/4 hours. It was erected by a single traveler with a 30x30-ft. tower 20 ft. high, which had four double-flanged wheels moving on a pair of rails about 30 ft. apart. On top of the tower there were two stiff-leg derricks with ten-ton 70-ft. booms operated by a two-drum, four-spool hoisting engine. Each boom has hoisting and topping lift tackles and a single whip line, the latter operated by one of the spools and used for rapidly handling the lighter members. The erecting force was divided into two equal gangs, each of which erected the two columns and 30-ft. roof trusses on one side of the building together with the longitudinal truss and other longitudinal members, after which both parties united in erecting with the two booms the 60-ft. center aisle roof truss. The two gangs worked in competition and were followed by the riveters. Afterwards the roof sheathing and waterproofing were rapidly applied and the brick walls were built with corresponding expedition, so that the building was virtually completed April 24, the first steel

having been erected March 1. This rapid work is believed to excel previous records for the same kind of construction and is considered by the contractors to be largely due to the completeness with which the preliminary plans and erection drawings were prepared in the office. The walls contained about 1,000,000 wire-cut bricks made by the Kingsland Brick Co., and laid in Atlas Portland cement mortar.

This building, together with the others to be erected for the plant was designed by Mr. D. C. Newman Collins, now of the Miller-Collins Co., who have been awarded the contract for the



superstructures. The drawings were made and the work in the field was done under the direction of Mr. E. M. Lee, chief engineer. The Passaic Steel Co. was the contractor for the structural steel. The construction of foundations in the field, was in charge of Mr. C. L. Watcher, engineer for the Lidgerwood Co.

THE POPULATION of New York City is 4,013,000 and is increasing 3 per cent. annually. The daily water consumption is increasing 15,000,000 gal.

The Stresses in the Horizontal Girder of an Elevated Tank.

By C. E. Day, Berkeley, Cal.

In a recent design of an elevated tank for a water supply system, the writer had occasion to analyze the stresses in the horizontal girder which was built to take the horizontal thrust at the top of the posts, due to the posts' inclination from the vertical. Although this girder forms the critical point in the design of the tank and is almost universally employed in the more recent designs of the better class of tanks, the writer, after considerable search, was unable to find any development of suitable formulas. However, references, with application, to the formula developed by Messrs. C. W. L. Filkins and E. J. Foote in the "Transactions" of the Civil Engineering Association of Cornell University of 1896, were found. Not wishing to adopt the formulas without knowing the basis of the analysis, the writer made the following study, which he hopes will be of interest.

In general the girder will be acted upon by two or more pairs of forces acting at the extremities of a diameter. For simplicity consider one such pair of forces acting. Then by the principle of superposition the stresses at any point will be the algebraic sum of the stresses due to each pair of forces. See diagram on next page.

Let the circular curve $A B C D$ represent the neutral surface of the horizontal girder acted upon by the two equal but opposite forces H , the horizontal thrusts at the top of the posts. Cut the girder at A and C and consider half of the load H acting on each side of the section. The transverse shear at A is $H/2$ and the bending moment at any point R is

$$M_R = M - \frac{1}{2} H R \sin \alpha \quad (1)$$

M is the bending moment at A .

Let M_t = the stress at any section in the fibre at a unit distance from the neutral curve; P = stress in same fibre due to H ; X = a distance from neutral curve; dA = an elementary area; I = moment of inertia; S = length along the neutral curve, and E = the modulus of elasticity.

Then, $x t M$ = the stress in the fibre at a distance x from the neutral curve. $x t M dA$ = the small force acting at that fiber. Similarly the stress due to H is $x P$. The elongation per unit of length is $x P / E$. For an elementary length the elongation is $(x P / E) ds$. If the bending moment M be gradually applied during the elastic elongation due to H the differential internal work will be

$$dw = - t M p ds x^2 dA \div 2E$$

The total internal work will be

$$W = \int_0^s \int_0^A (- t M' P ds x^2 dA \div 2E) = \int_0^s (- t M' P ds I \div 2E).$$

If the total angular displacement due to H is D the total external work will be $- \frac{1}{2} M D$. From the principle of the conservation of energy

$$- \frac{1}{2} M D = \int_0^s - t M' P ds I / 2E \quad (2)$$

Suppose now that M be gradually applied. The total angular displacement will be reduced to zero, since the tangents at A and C remain unchanged. As before the small force acting on the fiber at a distance X from the neutral curve is $x t M dA$. The elongation due to the same force is $x t M' / E$. The elementary internal work will be

$$dW = [(t M')^2 x^2 dA ds \div 2E].$$

Various colors are imparted to concrete by the mixture of certain mineral pigments, which, with proper care, are made to produce pleasing effects and do not appear to have a bad effect on strength or durability.

Thoroughly satisfactory methods of both waterproofing and coloring are still undeveloped, and the possible effect on the fire resistance of the block of treatment for these purposes is somewhat uncertain, though no serious objection on that score has developed thus far.

Another feature of block making which is still in process of development is the best method of curing or ageing them. The common way has been to store them in a shed or open yard for a month or so and sprinkle them with water once or twice a day, to prevent too rapid drying at the surface. Recently some manufacturers have practiced a quick method of curing by placing the blocks in a tightly closed receptacle and subjecting them to live steam under considerable pressure.

On account of lack of experience of their manufacturers, the concrete blocks as found to-day throughout the country vary largely in appearance, strength, waterproof quality and doubtless also in fire resistance. Some of those examined by members of this committee have every indication of being strong and durable and at least the equal in fire resistance of natural limestone, but many others appear very porous and weak, and some which have been submitted to members of this committee for fire tests have actually disintegrated in the course of a few months while waiting for trial.

The form in which most of these small blocks are made involves a certain weakness under severe temperatures which, while by no means fatal to the fire resistance, places a limitation on that quality which must be recognized, viz: They are subject to breakage by unequal expansion under heat, the same as is hollow tile or any other similar hollow material. Hollow blocks of concrete or tile as set in the walls or floors of a building usually present only one surface to the direct attack of fire, and the consequence is that that side or face of the block expands readily and irresistibly under the influence of the heat, while the other three sides receiving much less heat do not expand nearly as rapidly, with the result that the hottest side breaks away from the others. This has been demonstrated in actual fires and experimental tests for both concrete and tile. Failure from this cause would naturally occur soonest in blocks having a thin shell, inasmuch as the thinner the shell of the block towards the fire, the more quickly it will heat through and consequently expand. This breaking by unequal expansion has sometimes been referred to as a bursting due to pressure of steam or gases generated in a large hollow space or cell of the block, but a very brief analysis of the conditions will easily disprove any such statement. In the first place, there is generally no means of getting water into the interior of a block and no probability of gases from other sources being introduced therein, but if it were possible to get gas or steam into the interior, these cells are so continuous in a wall or floor and have so many vents to the atmosphere at the top of the wall or through mortar joints that the accumulation of the number of pounds' pressure necessary to burst an ordinary small block would be an impossibility under working conditions.

As already stated, this committee does not feel justified in presenting a standard for concrete blocks until the investigations now under way are completed, but shall hope to do so in another year; in the meantime trust the foregoing brief review of the progress of the art may be of some interest.

Reinforced Concrete Construction.—Many questions as to the best design of reinforcement and

methods of computing dimensions and values of the various parts of a beam, column or other member are still under discussion between engineers, and investigation is still in progress as to the relative fire resistance of concrete made of various materials and different proportions of mixture, so we are not yet prepared to specify the entire detail of construction which might come within the range of the general requirement of proper design and adequate insulation. We would like to emphasize again, however, the fact that a concrete building even if designed along the most approved lines of the present day engineering may be very good or very poor as to fire resistance according as the selection of materials and execution of the entire work is intelligently and honestly carried out or otherwise. However engineers may differ as to design, practically all are agreed that high-grade, tested, Portland cement conforming to the standards of the various engineering societies and clean, sharp sand are absolutely essential to good results. Furthermore, proper proportions of materials and thorough machine mixing to produce a dense rich concrete with practically no voids is necessary; steel members must be insulated by two to three inches of concrete, no concrete should be made in cold weather without extreme care being taken to prevent freezing of the mixture (a very difficult point to guard, by the way), joints between old and new concrete must be carefully made and temporary supports must not be removed until the cement has had time to thoroughly harden. All these features represent points of possible weakness in this type of construction and lack of attention to them in many cases has resulted in producing buildings not entitled to the term fireproof and even inadequate to the normal duties for which they were designed.

As above stated, however, experience is rapidly tending to reduce these defects, and there are to-day buildings of concrete construction justly entitled to a high place in fireproof classification.

During the past year the National Board of Fire Underwriters has recommended a "Building Code," which includes a standard for concrete construction, a copy of which is appended hereto. In the preparation of this standard the National Board Committee secured the best expert advice and presents this as the best obtainable up to this time, but expects to revise it from time to time as future experience may warrant.

Code Rules.—The term "reinforced concrete" or "concrete-steel" in this section shall be understood to mean an approved concrete mixture reinforced by steel of any shape, so combined that the steel will take up the tensional stresses and assist in the resistance to shear.

Reinforced concrete construction may be accepted for fireproof buildings, if designed as hereinafter prescribed; provided, that the aggregate for such concrete shall be hard-burned broken bricks, or terra cotta, clean furnace clinkers, entirely free of combustible matter, clean broken stone or furnace slag, or clean gravel, together with clean siliceous sand, if sand is required to produce a close and dense mixture; and, provided further, that the minimum thickness of concrete surrounding and reinforcing members one-quarter inch or less in diameter shall be one inch; and for members heavier than one-quarter inch the minimum thickness of protecting concrete shall be four diameters, taking that diameter, in the event of bars of other than circular cross-section, which lies in the direction in which the thickness of the concrete is measured; but no protecting concrete need be more than four inches thick for bars of any size; and provided, further, that all columns and girders of reinforced concrete shall have at least one inch of material on all exposed surfaces over and above that required for structural purposes; and all beams and floor slabs shall have at least three-quarters inch

of surplus material for fire-resisting purposes; but this shall not be construed as increasing the total thickness of protecting concrete as herein specified.

All the requirements herein specified for protection of steel and for fire-resisting purposes shall apply to reinforced concrete filling between rolled-steel beams, as well as to reinforced concrete beams and to entire structures in reinforced concrete. Any concrete structure or the floor filling in same reinforced or otherwise, which may be erected on a permanent centering of sheet metal, or metal lathing and curved bars or a metal centering of any other form, must be strong enough to carry its loads without assistance from the centering, unless the concrete is so applied as to protect the centering as herein specified for metal reinforcement.

Exposed metal centering or exposed metal of any kind will not be considered a factor in the strength of any part of any concrete structure, and a plaster finish applied over the metal shall not be deemed sufficient protection.

All concrete for reinforced concrete construction whenever used in such buildings must be mixed in a machine which mixes one complete batch at a time, and entirely discharges it before another is introduced. At least twenty-five complete revolutions must be made at such a rate as to turn the concrete over at least once in each revolution for each batch.

Before permission to erect any concrete-steel structure is issued, complete drawings and specifications shall be filed with the Commissioner of Buildings, showing all details of the construction, the size and position of all reinforcing rods, stirrups, etc., and giving the composition of the concrete.

The execution of work shall be performed by workmen under the direct supervision of a competent foreman or superintendent.

The concrete shall be mixed in the proportions of one of cement, two of sand and four of other aggregates as before provided; or the proportions may be such that the resistance of the concrete to crushing shall not be less than 2,000 pounds per square inch after hardening for twenty-eight days, but for reinforced or plain concrete columns the mixture shall not be leaner than one part of cement, two of sand and five of the coarser aggregate in any case. The tests to determine this value must be made under the direction of the Commissioner of Buildings. The concrete used in concrete-steel construction must be what is usually known as a "wet" mixture.

Only high-grade Portland cements shall be permitted in reinforced concrete or concrete-steel constructed buildings. Such cements, when tested neat, shall, after one day in air, develop a tensile strength of at least 300 pounds per square inch; and after one day in air and six days in water shall develop a tensile strength of at least 500 pounds per square inch; and after one day in air and twenty-seven days in water shall develop a tensile strength of at least 600 pounds per square inch. Other tests, as to fitness, constancy or volume, etc., made in accordance with the standard method prescribed by the American Society of Civil Engineers, may, from time to time, be prescribed by the Commissioner of Buildings.

The sand to be used must be clean, sharp grit sand, free from loam or dirt, and shall not be finer than the standard sample kept in the Department of buildings.

The stone used in the concrete shall be a clean, broken stone, of a size that will pass through a three-quarter inch ring, or good gravel may be used in the same proportion as broken stone, or broken hard bricks, or terra cotta, or furnace slag, or hard clean clinkers may be used.

The steel shall meet the requirements of Section 21 of this Code. (All structural steel shall have

an ultimate tensile strength of from 54,000 to 64,000 pounds per square inch. Its elastic limit shall be not less than 32,000 pounds per square inch and test specimens, ruptured in tension, must show a minimum elongation of not less than 20 per cent. in eight inches. Rivet steel shall have an ultimate strength of from 50,000 to 58,000 pounds per square inch.)

Concrete-steel shall be designed in accordance with the following assumptions and requirements:

(1) The adhesion between the concrete and the steel is sufficient to make the two materials act together; the unit value of the adhesion is at least equal to the unit shearing strength of concrete.

(2) The design shall be based on the assumption of a load four times as great as the total working load (ordinary dead load plus ordinary live loads) producing a stress in the steel equal to the elastic limit, and a stress in the concrete equal to two thousand pounds per square inch.

(3) The modulus of elasticity of concrete at two thousand pounds per square inch is equal to one-eighteenth of the modulus of elasticity of steel.

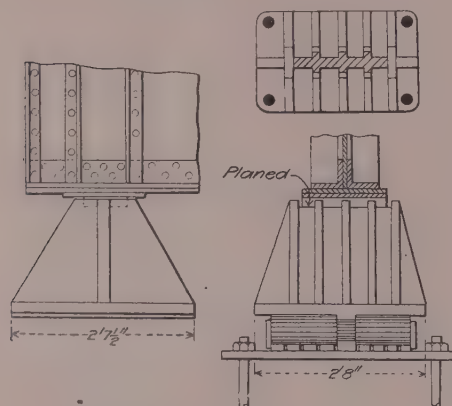
(4) The steel takes all the tensile stress.

(5) The stress-strain curve of concrete in compression, when the stress in the extreme fiber is two thousand pounds per square inch, may be assumed.

(a) As a straight line.

(b) As a parabola with its axis vertical and its vertex on the neutral axis of the beam, girder or slab, or

(c) As an empirical curve with an area one-



Lock Bearing for Expansion End.

quarter greater than if it were a straight line, and with its centre of gravity at the same height as that of the parabolic area assumed in (b).

(6) The assumption belonging to the common theory of flexure, where not modified by any of the foregoing, will apply.

In the design of structures involving reinforced concrete girders and beams, as well as slabs, the girders and beams shall be treated as T-beams, with a portion of the slab acting as flange, in each case. The portion of the slab so acting shall be determined by assuming that in any horizontal-plane section of the flange, the stresses are distributed as the ordinates of a parabola, with its vertex in the stress-strain curve, and with its axis in the longitudinal vertical plane through the center of the rib of the T.

The shearing strength of concrete, corresponding to a compressive strength of two thousand pounds per square inch, shall be assumed at two hundred pounds per square inch.

All reinforced concrete T-beams must be reinforced against the shearing stress along the plane of the junction of the rib and the flange. Where reinforced concrete girders carry reinforced concrete beams, the portion of the floor slab acting as flange to the girder must be reinforced with bars near the top, at right angles to the girder, to enable it to transmit local loads directly to the

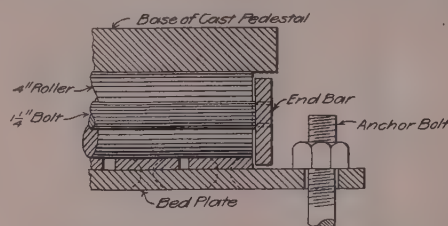
girder and not through the beams, thus avoiding an integration of compressive stresses due to simultaneous action as floor slab and girder flange.

Concrete indirect compression shall not be stressed, under the working load, more than three hundred and fifty pounds per square inch. Reinforced compression members shall be designed on the assumption that this stress in the concrete will be simultaneous with one of six thousand pounds per square inch in the steel. Should the use of hooped concrete be proposed, the working stresses will be a subject for special consideration by the Commissioner of Buildings.

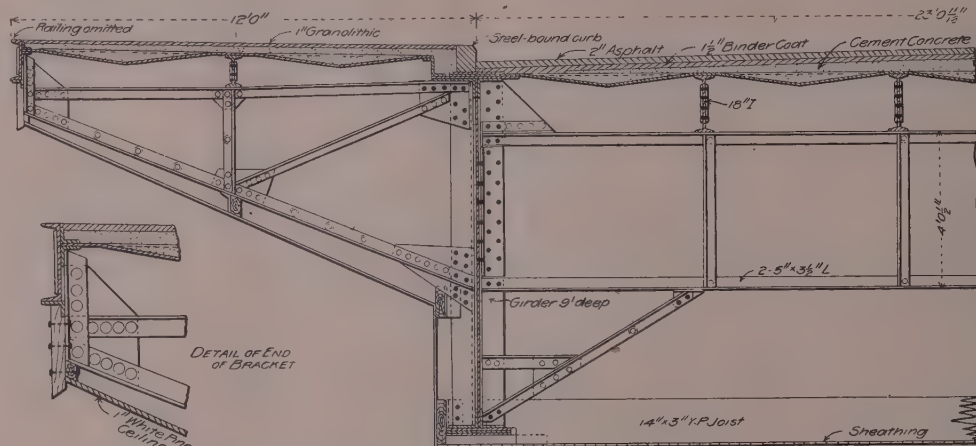
In the execution of work in the field, work must be so carried on that the ribs of all girders and beams shall be monolithic with the floor slab.

In all reinforced concrete structures, special care must be taken with the design of joints to provide against local stresses and secondary stresses due to the continuity of the structure.

In the determination of the bending moments due to the external forces, beams and girders shall



Detail of Roller and Bed Plate.



Section Showing Connections to Outer Girder and Protection from Smoke.

be considered as simply supported at the ends, no allowance being made for continuous construction over supports. Floor plates, when constructed continuous and when provided with reinforcement, at top of plate over the supports, may be treated as continuous beams, the bending moment for uniformly distributed loads being taken at not less than 0.1 WL; the bending moment may be taken at 0.05 WL in the case of square floor plates which are reinforced in both directions and supported on all sides.

When the shearing stresses developed in any part of a reinforced concrete or concrete-steel constructed building exceed under the multiplied loads, the shearing strength as fixed in this section, a sufficient amount of steel shall be introduced in such a position that the deficiency in the resistance to shear is overcome.

When the safe limit of adhesion between the concrete and steel is exceeded provision must be made for transmitting the strength of the steel to the concrete.

Concrete-steel may be used for columns in which the ratio of length to least side or diameter does not exceed twelve. The reinforcing rods must be tied together at intervals of not more than the least side or diameter of the column.

The contractor must be prepared to make load tests of any portion of a reinforced concrete or

concrete-steel constructed building within a reasonable time after erection as often as may be required by the Commissioner of Buildings. The tests must show that the construction will sustain a load with a factor of safety for floors and structural members as required by Section 136 of this Code.

Special Details of a Long Plate-Girder Span.

The Thirty-third St. highway bridge over some railroad tracks near the Girard entrance of East Fairmont Park, Philadelphia, has several through plate-girder skew spans. The longest have three lines of main girders about 109 ft. over all, which are seated on masonry piers and abutments illustrated in this journal on March 3, when the interesting features of the girder erection by a gin pole were described. These girders are 9 ft. 1/2 in. deep from back to back of the 8x6-in. flange angles.

The bottom flanges have full length 20x3/4-in. cover plates, to each end of which there is riveted a 20x1/2-in. filler plate 13 in. long. These plates are about 7 in. clear of the ends of the girders and cover the ends of two pairs of vertical web-stiffener angles about 7 in. apart, back to back, which are fitted to the flange angles and reinforce the web for the maximum end shears. On the center lines of these filler plates there are riveted 4x1 1/8-in. plates extending across the full width of the cover plate and beveled to corre-

spond with the grade.

These plates engage the tops of the cast-steel pedestals and are seated on the planed upper edges of the longitudinal and transverse webs, which are recessed 3/4 in. so that the ends of the webs project above the girder bearing and form guards, locking the latter in position. The heights of the pedestals vary from about 8 to 12 in., according to the grade, and both fixed and expansion pedestals are alike except in the base plate, which for the fixed end does not have the center guide rib provided on the expansion pedestal to engage the rollers. Each roller nest is made of five 4-in. rollers 31 1/2 in. long over all, which have shouldered ends engaging side strips fastened together by a pair of 1 1/4-in. shouldered bolts between the outer roller and the next one to it on each side of the nest. The ends of these bolts are countersunk-riveted through the guide strips, and the latter are 4x3/4-in. bars eccentrically bored for the roller bearings, so that the upper edge of the strip has a clearance of 3/8 in. from the under side of the overhanging pedestal base and the lower edge projects 3/8 in. over the planed edge of the roller bearing. The roller bed is made with a 31 1/2 x 7/8 x 40-in. base plate, to which are riveted eight 3-in. longitudinal strips 3 3/8 in. apart on centers, planed to a thickness of 3/8 in., and a 2 1/2 x 3/4-in. center guide strips.

The asphalt roadway, 46 ft. $1\frac{3}{4}$ in. wide, is of the standard city type; is crowned 6 in., and is laid on a concrete foundation on buckle plates laid convex side down on 18-in. longitudinal I-beams supported on the top flanges of the floorbeams, where they have butt joints spliced with riveted web cover plates. The floorbeams are web-connected to the vertical stiffener angles in the main girders, and are also kneebraced to them by solid web plates on the top flanges, and by pairs of angles on the bottom flanges. The two 12-ft. sidewalks are of similar construction to the roadway, but are carried on much lighter stringers. The center one is composed of a 10-in. I-beam, the outer one is a 12-in. fascia channel, and the one nearest the curb is made of a $6 \times 3\frac{1}{2}$ -in. Z-bar which, like the buckle plate, is field riveted to the edge of the 24-in. first top flange cover plates of the main girders that project each side of the 17-in. upper cover plate so as to provide for these connections.

The bridge is protected from the smoke and locomotive gases of trains passing under it by a sheathing of 1-in. tongue and groove planed white pine fencing lumber, which forms a continuous shield tightly enclosing the superstruc-

Concrete Pavements in Chicago.

The adaptability of concrete pavements to heavy traffic has been severely tested in Chicago during the last two years, with uniformly good results. In all, about 50,000 sq. yd. of these pavements have been laid in that city and vicinity, according to a special method devised by the R. S. Blome Co., of Chicago. Concrete pavements for alleyways, railroad yards and driveways carrying heavy teaming traffic have been built by this company on a more or less limited scale for the last twelve years. During the past two years, however, this type has been laid by this company on streets in various parts of the city, chiefly in the vicinity of large manufacturing plants. Several streets and alleyways in the United States stock yards and a street and several driveways at the manufacturing plant of the Western Electric Co. have been so paved.

A 40-ft. street, paved with concrete for a length of 2,000 ft., is shown in the accompanying illustration. This pavement was laid on a clay soil which was first carefully rolled to the sub-grade.

A 6-in. cinder base was then placed on the pre-

This particular stretch of pavement has been in service for two years. It is subjected to a heavy traffic from several factories, but its surface shows very little wear, as may be seen in the accompanying illustration. The blocks have not crumbled or chipped off at the edges and the pavement wears evenly at the joints. The granite used in the surface coat is dark enough in color to prevent any glare from the surface of the pavement. The smoothness of the surface permits dirt to be readily washed from it into the gutters, the accompanying picture showing a street which is not regularly cleaned. The pavement being laid in sections, these sections may be easily removed when trenches for water, gas or other underground pipes have to be opened, and can be readily replaced.

The concrete pavements that have been laid in other parts of the city have been constructed according to the same general method followed in laying the pavement shown here. In some cases the surface has been separated into 4×9 -in. blocks and in other instance, a 6-in. macadam base has been laid instead of the cinder base. The concrete is generally allowed to set about as long as a concrete base for any other type of



— The Surface of a Concrete Street Laid in Chicago Two Years Ago.

ture except on the upper surface. Between the main girders the longitudinal sheathing boards are fastened with galvanized wire nails to the under side of 3×14 -in. yellow pine transverse joists 4 ft. apart on centers, with notched ends resting directly on the lower flanges of the girder and locked to them by $2\frac{1}{2} \times 2\frac{1}{2}$ -in. horizontal bottom strips spiked to each end so as to project under the girder flanges. The outer sides of the outer girders and the space below the sidewalk is cased with vertical and transverse inclined sheathing nailed to 3-in. longitudinal pieces bolted to the main girders and sidewalk brackets with short connection angles. Where the upper end of the inclined sheathing is connected to the 16×2 -in. fascia boards the joint is protected by the latter and the sheathing is nailed to a 4×2 -in. beveled nailing strip bolted near the lower edge of the fascia.

The bridge was designed and constructed under the direction of Mr. George S. Webster, chief engineer, Bureau of Surveys, Philadelphia, and was detailed, manufactured and erected by Lewis F. Shoemaker & Co., Schuylkill Bridge Works, Philadelphia and Pottstown, Pa.

pared sub-grade and well rolled into place. A layer of concrete with a total thickness of 7 in. was laid directly on the cinder base. The lower $5\frac{1}{4}$ in. of the layer consists of 1 part Portland cement to 7 parts of sand and crushed stone aggregate, the portions of the latter being varied with the fineness of the material received. This layer of the concrete was mixed fairly wet in a R. S. Blome Co. mixer, and well tamped into place. A surface, or wearing coat, $1\frac{3}{4}$ in. thick, was laid on the lower layer of concrete before the latter had received its initial set. This surface coat consisted of mortar made of 1 part Portland cement to $1\frac{1}{2}$ parts crushed granite. The crushed granite would all pass a screen with $\frac{1}{4}$ -in. meshes, but had the fine dust screened out, the average size of the pieces being about $\frac{1}{8}$ in.

The pavement was built with a $\frac{1}{4}$ -in. transverse joint every 50 ft., and with a longitudinal joint along the gutter on each side. The surface of the pavement is separated into $3\frac{1}{2} \times 8$ -in. blocks, according to a special method also devised by the R. S. Blome Co. The separation between the blocks is thoroughly made and is of sufficient depth to provide a secure foothold for horses.

pavement is allowed to stand before traffic is turned on the pavement. A contract to lay 30,000 sq. yd. of pavement of this type in Calumet, Mich., has recently been awarded to R. S. Blome & Co., and will be completed during the summer.

STOPPED TUYERES AND TAP-HOLES in furnaces can be opened by a novel use of oxygen. At the recent meeting of the Iron & Steel Institute, a solid steel block 16 in. long and 6 in. square was placed in an iron tripod, and a gas burner adjusted in line with its longitudinal axis and a few inches from one end. The burner consisted of concentric pipes, the outer for hydrogen and the inner for oxygen. Hydrogen gas was first turned on and ignited. The oxygen was then turned on, both gases being under a low pressure at first, which was gradually increased. Eventually the pressure of the oxygen was raised to 30 atms. and the hydrogen shut off. The high-pressure oxygen burned a 2-in. clean hole through the steel in 1 minute 13 seconds from the time the hydrogen was lighted, according to "Engineering," but without raising the outside temperature of the block so high as to prevent keeping the hand on it.

The New Steel Pier Sheds on the East River, New York.

The present policy of New York City is to acquire by purchase or condemnation the water front not previously owned and to improve it by the construction of standard piers which are leased for terms of ten years with privileges of two ten-year renewals, after which the buildings on them revert without purchase to the city. In accordance with this policy extensive improvements are now being made along the East River from Pier No. 8, near Coenties Slip to Fulton St., a length of about 2,000 ft., which will be occupied by seven new piers chiefly of the standard width and length with slips from 160 to 200 ft. in width between them. These will cover the space formerly devoted to twelve old piers and slips, the former of which are being removed as rapidly as possible.

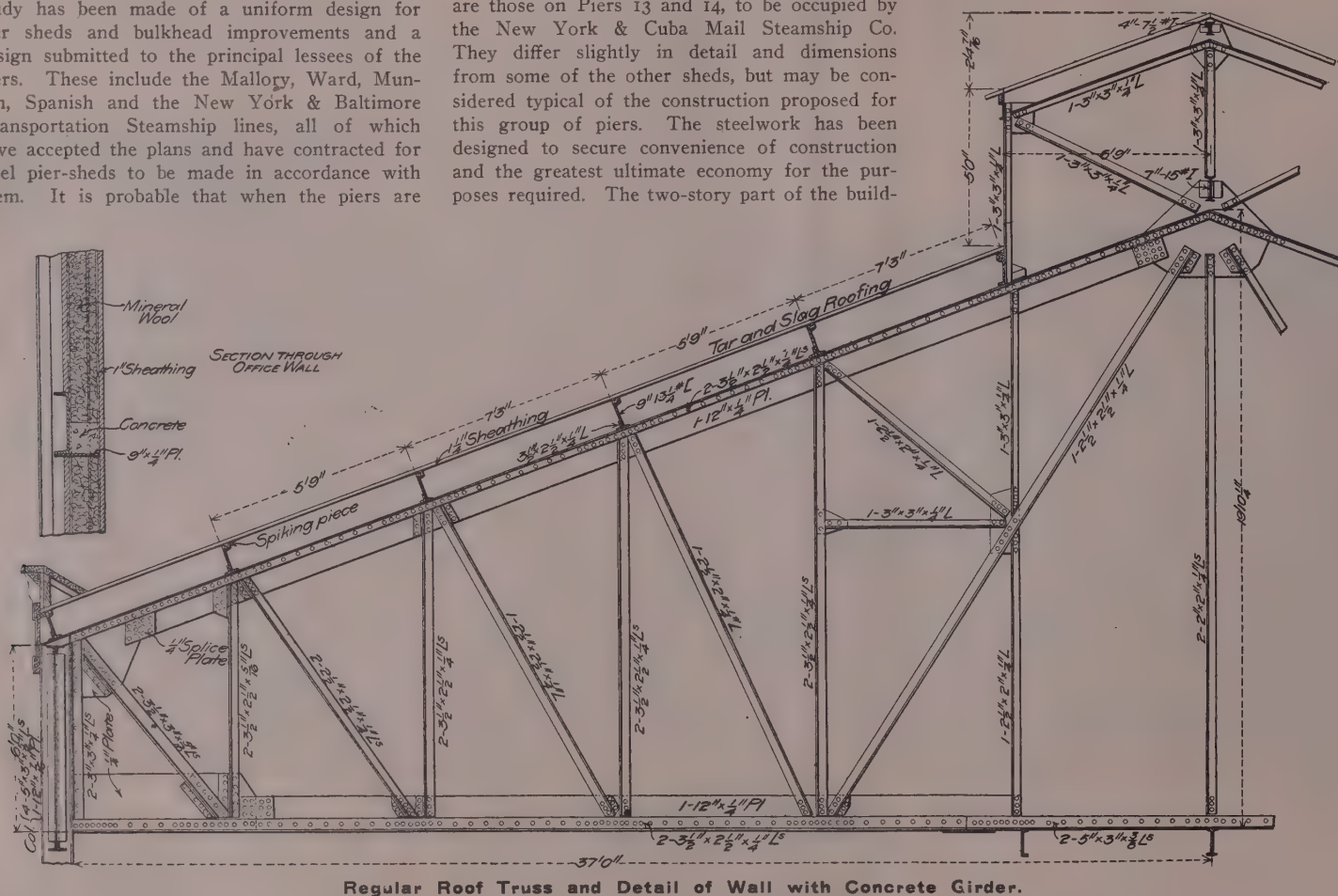
In view of these radical changes a careful study has been made of a uniform design for pier sheds and bulkhead improvements and a design submitted to the principal lessees of the piers. These include the Malloy, Ward, Munson, Spanish and the New York & Baltimore Transportation Steamship lines, all of which have accepted the plans and have contracted for steel pier-sheds to be made in accordance with them. It is probable that when the piers are

together with the ends of the piersheds, will form a continuous facade along the river front, screening slips and presenting an appearance which will be a great improvement over prior conditions. Most of the piersheds are two stories high at the shore end to accommodate the offices, and their street fronts will have architectural treatment emphasizing the construction and presenting a harmonious appearance. These fronts will be connected by the face of the bulkhead buildings and the latter will be panelled to relieve the long surfaces and afford openings for freight entrances. An attractive design for this front has been prepared and submitted to the dock commission and to the pier tenants. The latter approve of it and if the city accepts it, it will be constructed and will afford a considerable revenue for ground rental besides constituting a permanent improvement eventually becoming the property of the city.

Among the piersheds now under construction are those on Piers 13 and 14, to be occupied by the New York & Cuba Mail Steamship Co. They differ slightly in detail and dimensions from some of the other sheds, but may be considered typical of the construction proposed for this group of piers. The steelwork has been designed to secure convenience of construction and the greatest ultimate economy for the purposes required. The two-story part of the build-

light X-brace rods in the planes of the top chords of the roof trusses in alternate panels and by X-braces between the trusses in the vertical plane through the longitudinal center line. In one of the side walls there is longitudinal X-bracing in every other panel and in the other side wall there are longitudinal latticed girders 7 ft. deep connecting the tops of the columns in alternate panels. The end walls and the side walls down to the lower flanges of the latticed girders are covered with galvanized corrugated steel. The top chords of the trusses are connected by 9-in. channel purlins 5 ft. 9 in. and 7 ft. 3 in. apart alternately, which carry the transverse 1¼-in. sheathing boards for the roof.

The wall columns have I-shaped cross-sections made of four light angles and a web plate, and at their upper ends are field-riveted through the inner flanges to the vertical end posts of the roof trusses. The latter are shop riveted as far as possible and are made, as shown in the ac-



entirely reconstructed they will all be provided with practically uniform warehouses, making a thoroughly up-to-date provision for freight and passenger traffic.

The new piers are of standard pile construction in water of a maximum depth of 30 ft., their width varies from 60 to 80 ft. and their length is about 550 ft. The piersheds are generally one-story steel structures covering the entire width of the pier except 1 ft. on each side and extending from the bulkhead line to within 20 ft. of the river end. They are made with 20-ft. longitudinal panels and transverse bents consisting of a pair of columns and a riveted double-pitched roof truss, covered with galvanized corrugated No. 22 steel sheathing on the sides and with wooden boards on which is laid tar and slag roofing.

It is proposed to unite the shore ends of the piersheds by a continuous steel bulkhead house about 50 ft. wide and 25 ft. high in the clear, which will be parallel with the shore line. This,

ing is 74½ ft. long and contains offices on the lower floor and a passenger waiting room on the second floor. The main shed, exclusive of the two-story portion at the shore end, is about 450 ft. long and 76 ft. wide, out to out, and is 21 ft. high in the clear below the roof truss and about 46 ft. high over all.

The long sides are entirely closed by sliding doors and the building is lighted by the pivoted windows in the clerestory of a monitor 13½ ft. wide and 5 ft. high. A footway 12 ft. wide is carried on the lower chords of the roof trusses through the axis of the building from end to end, and has four transverse platforms 10 ft. wide near the center for communication with the upper decks of the vessels in the slips alongside, without obstruction by the freight and storage on the deck of the pier. At the river end the last two trusses are special and carry on their lower chords a second floor occupied by a carpenter shop 22½ ft. wide and 74 ft. long.

The framework is braced longitudinally by

companying semi-elevation, with all the members composed of single angles or pairs of angles riveted back to back. The top and bottom chords have additional web plates wide enough to afford connection without the use of gusset plates for the ends of the web members. Special care is taken to provide connections developing the strength of both flanges of the angles in the principal web members.

The tracks for the sliding doors are arranged so that the latter alternate in two parallel planes and adjacent doors can always slide by each other without interference. In alternate panels the tracks are attached to the lower ends of fan doors and the latter are arranged with hinges on their horizontal upper edges so that when the sliding doors are moved to the tracks on the adjacent panels the fan doors can be revolved up to the height of the eaves, thus providing for increased headway in the openings of alternate panels.

Wherever there are double thicknesses of wall

siding, there are introduced, at short vertical intervals, solid concrete girders between the inside and outside sheathing. These girders not only form fire stops and stiffen the framework of the building, but serve as bridges to carry mineral wool with which the space between the inner and outer walls is filled, thus providing insulation and fireproofing. Each regular roof truss weighs about $3\frac{1}{2}$ tons, and the total weight of structural steel in the piershed is about 616,000 lb.

In the erection of the framework the columns are first set in place by movable derricks, or by booms and travelers, after which the roof trusses are erected complete by a traveler of the standard form adopted by the contractors for this class of work. It consists of a single transverse bent made of two vertical posts about 20 ft. apart and 60 ft. high, braced together with horizontal struts and diagonals. They are seated on a pair of longitudinal sills with braces from their rear ends to points about one-third of the way down from the top of the vertical posts, thus forming a simple stable tower which moves longitudinally on the pier deck with a solid

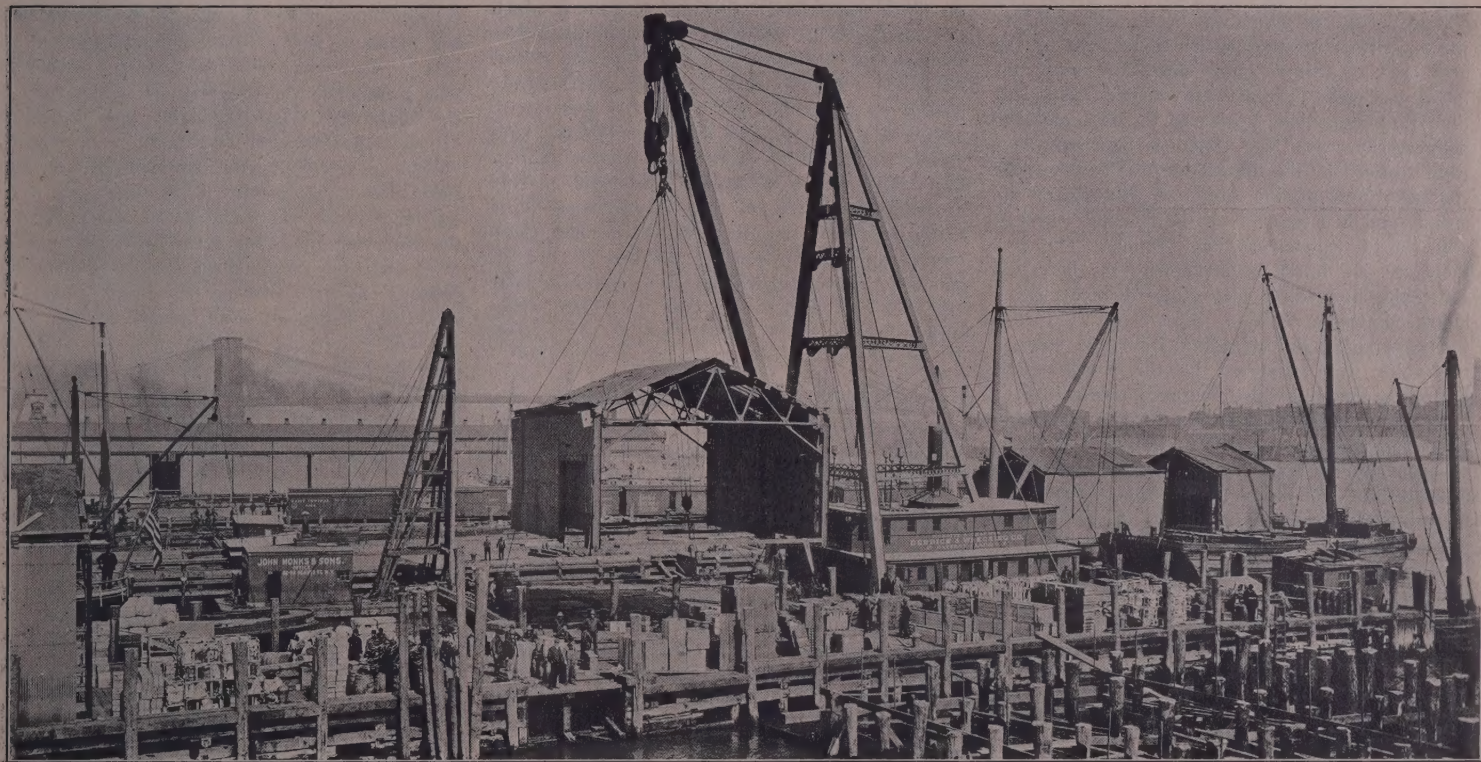
considerable stiffness from the steel purlins for the wooden roof and from the sheathing and longitudinal guard timbers bolted on to protect the sheathing from injury. The sheathing, purlins and other longitudinal members were removed in every third panel leaving the building practically intact for six 40-ft. sections alternating with 20-ft. open spaces. Each of these sections consisted of three transverse bents with the original roof, siding, and doors attached. The feet of the vertical columns were connected by 6x12-in. horizontal braces, the anchor bolts securing the columns to the deck of the pier were removed, and holes were cut through the corrugated roofing at each end of each truss.

A floating derrick with a 100-ft. boom having a capacity of 100 tons was secured from the Merritt & Chapman Derrick & Wrecking Co. and towed to the slip between the two piers. To the lighter of the two tackles with which the boom was provided four $\frac{3}{4}$ -in. steel wire ropes of exactly equal length were secured at one end and the other ends were passed through holes

and deposited it in the same manner on the new pier 20 ft. clear of the first section.

This operation was repeated until the whole of the old piershed was removed to Pier No. 10 in $1\frac{1}{2}$ days, four of the 40-ft. sections having been handled in one day. They were seated with the columns of one wall close to the edge of the pier in line for the new shed. When the latter is built the columns and framework for this side will remain in position and will be secured to the new trusses and the old trusses will be removed and the sheathing and columns for the opposite side will be moved transversely to the new line of the opposite wall where they will be permanently secured.

The spaces between the sections of the old building were filled in with the old purlins and longitudinal members, assembled as required and covered with the old galvanized sheathing supplemented by a few pieces of new sheathing required to supply the deficiencies. This operation was very successfully performed and was considered to effect a considerable economy besides promoting the convenience of the steamship line by pro-



View Showing Section of Piershed Being Transferred from Old to New Pier.

wooden roller under each corner. The vertical posts have connections just above the middle points, with booms which are sometimes used and sometimes are replaced by simple tackles with which the trusses are hoisted to position.

New Pier 10, adjacent to old Pier 11, is separated from it by a slip 160 ft. wide. After the new pier was built preparations were made for the removal of the old pier, and it was determined to utilize the steel piershed 35 ft. wide and about 340 ft. long from old Pier 11 for a temporary shelter on the new pier before the permanent steel structure there is built. The old shed is of light construction with transverse bents consisting of a riveted roof truss and a pair of knee-braced vertical columns spaced 20 ft. apart and covered with corrugated iron roof and siding. To have taken it apart and reassembled it on the new pier would have been very expensive. A scheme was devised, however, for moving it in sections without taking the framework apart or removing the sheathing and this has been successfully accomplished as shown in the accompanying photograph. The old shed derived

cut in the roof and made fast to the ends of the roof trusses, thus securing the section of the shed at all four corners. A second longer wire rope was attached to one end of the middle roof truss, passed through the connection to the tackle, and brought down near the opposite end of the same truss, where it was connected to a small tackle made fast to the end of the truss. This tackle was then operated until sufficient tension was developed in the rope to approximately equal that in the ropes attached to the four corners of the building.

The small tackle was then made fast and the large tackle lifted this section of the building, weighing about 20 tons, to a vertical height of 10 ft., clearing the fender piles alongside the dock. The derrick was then moved across the slip, the boom swung around and the section of the building was lowered to the required position on the new dock, the bottoms of the columns being secured by bolts already set to receive them in the 12x12-in. longitudinal sills provided for the purpose on the pier floor. The derrick then returned for another section of the old building

providing a new shelter for the freight as soon as the old shelter was removed, thus enabling business to be transferred without delay to the new pier while the old pier is being removed. All of this work was designed and is now being executed by John Monks & Sons, New York contractors; Mr. J. W. Ripley, engineer. The architectural features of the plan were designed by Messrs. Copeland & Dole.

PHOTOREDUCTION OF MAPS has been employed with marked economy by Mr. J. W. Woermann, U. S. assistant engineer. It was necessary to reduce maps on a scale of 1 in. to 400 ft. to a scale of $1\frac{1}{2}$ in. to the mile. The large sheets were 43 in. wide and 6, 10 and 12 ft. long. A 5x8-in. camera was employed, using Cramer's contrast plates for negatives and Eastman's Solio paper for prints. Graphite impression paper and styli were used in transferring the lines from the silver prints to the drawing paper. A 12-ft. map could be photographed on two 5x8-in. plates, but in order to eliminate any chance of distortion at the ends, three plates were used.

The Water Supply of San Francisco.

In the reconstruction of San Francisco an important part is being played by the Committee of Forty, a citizens' organization which is working out a co-ordinated group of projects to insure proper planning and organization of all features of the new city. Its sub-committee on water supply and fire protection, consisting of Major C. H. McKinstry, Corps of Engineers, U. S. A., chairman, and Messrs. Edwin Duryea, Virgil G. Bogue and J. Dalzell Brown, has filed its recommendations concerning water works, which are decidedly interesting. It reports that the distributing mains leading from the city reservoirs and tanks to the various sections of the city are, in general, of ample size, but many laterals and cross-connecting pipes are too small to furnish adequate fire protection. This statement as to the insufficient size of laterals and cross-connections is made on the authority of the underwriters' report. The demand for water at the time when the "earthquake-fire" occurred had reached a point where it was practically equal to the developed supply. This fact was recognized by the Spring Valley Water Co., which was on the point of closing a contract for the construction of the Calaveras dam, to form a large storage reservoir on Alameda Creek. The present consumption is less than that immediately prior to the fire, and the delivery capacity of the system is likewise somewhat reduced by the destruction of the Pilarcitos conduit. Consumption, however, will rapidly increase, and in a short time the demand will exceed the immediately available supply. The fire, therefore, has not done away with the necessity for taking immediate steps toward securing an increased supply.

The three conduits leading from the storage reservoirs were ruptured by the shock. The Pilarcitos conduit, which for a considerable portion of its length is frequently crossed by the fault line, was over such portion broken, telescoped, collapsed, pulled apart and damaged beyond the possibility of economical repair. The water company intends to abandon this line for service, a course which the report recommends as advisable. The most serious injury to the Crystal Springs and San Andreas conduits occurred at marsh crossings. The lesson of the earthquake is that marsh crossings should be avoided when possible. When soft ground must be crossed, permanent material and substantial construction should be used. If timber is used it should be protected from decay.

The failure to control the fire was not due to the breaking of the out-of-town conduits, but primarily to the fact that the 80,000,000 gal. of water stored in distributing reservoirs within the city, a quantity sufficient to check even such a conflagration, was rendered unavailable by reason of breaks in important distributing mains. The failures in the pipes of the distributing system occurred only in filled or soft ground, and were not due in any case to the use of poor material. To meet earthquake conditions, the main arteries of the distributing system should be so laid as to avoid as far as possible all places where slips and ground movements resulted from the earthquake, should have frequent cross-connections and should be furnished with a great number of gates and large hydrants properly disposed. All service pipes should be fitted with some device, such as a balanced valve, which will close automatically should the service pipe be broken.

Where soft or made ground must be crossed special precautions should be taken to protect the pipe from injury by settlement of the ground; for example, by the use of flexible joints, slip joints, unyielding supports and sinuous alignment. It is entirely practicable, in the committee's opinion, to provide a system of mains which, as a sys-

tem, will not be seriously injured by such an earthquake as that of April 18, or even one of greater severity. The character of the injury to the only one of the distributing reservoirs damaged by the earthquake shows that a sufficient quantity of water for successfully fighting fires can be safely stored within the city limits. To add to the quantity of water stored within the city limits the number of distributing reservoirs should be increased.

To afford additional fire protection within the congested value district the committee recommends that a separate system of mains be installed, to be supplied with water pumped from the bay. It advises the installation of two pumping stations on solid ground, one at the base of Telegraph Hill and the other at the base of Rincon Hill, each to be capable of delivering at least 7,500 gal. per minute, with a hydrant pressure of 200 lb. per square inch. The foundations of the suction lines should receive special care in design and construction. The main artery connecting the two stations should be swung to the westward sufficiently to avoid insecure ground.

The system should be fitted at several points on the water front with connections into which fire boats or other floating pumps could discharge. At least one such boat should be provided simultaneously with the installation of the separate system recommended. It should be fitted with pumps of the same capacity as one of the land stations, and with modern equipment for fighting fires along the dock front. To avoid marine growths and corrosion the system should normally be kept filled with fresh water under pressure, supplied from the regular service through connections provided with check valves, to prevent salt water from backing into the fresh water system.

Sewage Disposal at Baltimore.

The sewage disposal system recommended to the Baltimore Sewerage Commission by its Board of Advisory Engineers, Messrs. Rudolph Hering, F. P. Stearns and S. M. Gray, calls for septic tanks and sprinkling filters. The works for purifying 75,000,000 gal. are estimated to cost \$3,283,250, exclusive of expenditures for land, and their annual operating charges are placed at \$115,500, exclusive of interest and other fixed charges. This system is not unlike in principle that adopted at Columbus. The sewage passes first into septic tanks, where it remains from six to eight hours, depositing therein much of its suspended matter as sludge, which gradually is reduced in quantity and finally is discharged on adjoining lands.

The partially clarified liquid of the septic tanks flows to the sprinkling filters. These are beds of broken stone about 9 ft. in depth, upon which the sewage is discharged in the form of spray, from a large number of nozzles placed about 15 ft. apart at their surface. The sewage trickles or filters through the beds, a thin film of liquid surrounding each stone, and issues below freed from its putrescent matter.

This effluent then enters settling basins, where it remains about three hours and deposits the films of matter detached from the sprinkling filters. The removal of the bacteria by the septic tanks, sprinkling filters and settling basins is in the neighborhood of 95 per cent. of the number contained in the original sewage.

The final process of purification is secured by discharging intermittently the effluent from the settling basins upon artificial sand filters, by which substantially all the remaining bacteria and fine suspended matter are removed, so that the final effluent is clear and has obtained the "highest practicable degree of purity."

The settled effluent from sprinkling filters, when so designed and operated as to give a high

degree of purity, contains only from 3 to 5 per cent. of the bacteria in the crude sewage, and the organic matter is oxidized and so changed by bacterial action that the effluent is non-putrescible. Experiment shows that the effluent from sprinkling filters, when held in a settling tank, continues to oxidize and purify, and when turned into a considerable body of water there is a still further continuance of oxidation and destruction of the bacteria originally in the sewage. The advisory engineers believe that this settled effluent from sprinkling filters can be discharged into tidal waters near Baltimore without causing any offense, but in order to comply with the commission's instructions to devise a plan for the highest practicable degree of purification, it advises the intermittent filtration of the effluent through sand.

Book Notes.

Some of the readers of this paper have doubtless heard during the last year of a remarkable dictionary which has been in preparation by two German engineers, Messrs. K. Deinhardt and A. Schlomann. This has been mentioned a number of times in European publications and the first volume, which has just appeared, will show at a glance that the expectations of the value of the book were none too high. It is called the "Illustrated Technical Dictionary" and the first volume gives the English, German, French, Russian, Italian and Spanish terms relating to drafting office work, the elements of machinery and the tools for metal and wood working found in every machine shop. Eleven more volumes will appear shortly covering electrical apparatus, steam and hydraulic power plants, pumps, hoisting and conveying machinery, small tools and machine tools, railways and locomotives, structural steelwork, metallurgy, architecture and naval architecture. The contents are classified so that, for instance, all terms for screws, bolts, wrenches and the like are grouped together. The synonymous terms are further combined and accompanied by an illustration so that there can be no question that *schraubenzieher*, *tournevis*, *cacciavite* and *destornillador*, not to mention something in Russian type, all mean screwdriver. In other cases a formula is used instead of a picture to help identify the terms; for example, the expression $\frac{1}{2} m v^2$ makes clear instantly the fact that *arbeitsvermoege*, kinetic energy, force vive, *energia cinetica*, *fuerza viva* and something in Russian are synonymous. An excellent index enables one book to serve the purpose of many bilingual dictionaries. (New York, McGraw Publishing Co., \$2.00.)

ASSAINISSEMENT DES VILLES; DISTRIBUTIONS D'EAU. By A. Debauxe and Ed. Imbeaux. Paris, H. Dunod & E. Pinat. Three Vols. 6¼x9¾; one Vol. plates, 9¾x12½. 75 francs.

In many ways France has been a leader in sanitary matters. The beginning of the purification of the sewage of Paris upon the fields of Genevillier marked an epoch in the cleaning of rivers, and the unequalled works for the collection of spring water to supply that city showed an appreciation of the advantages of pure water and a willingness to go to great expense to get it, not often equalled even in more recent times. For many years France rested upon the laurels that came from these earlier works. There was not much new in sanitary matters to be learned there. Other countries took the lead in the purification of water and sewage, but recently there has been a renaissance, and in the last years the purification of public water supplies and the cleaning of rivers have been taken up with a vigor which again makes France a center of knowledge upon these subjects.

With this renewal of interest in sanitary matters there is appearing a large amount of literature, reflecting not only the progress now being made in France, but that in all the rest of the world as seen by French authors. A monumental example of this literature is the work, the title of which stands above, filling some two thousand pages in three large volumes, and accompanied by a fourth volume of plates. The work is divided into seven sections.

The first section treats of the principles of hydraulics, the flow of water in pipes, and methods of measuring water, etc.

The second section treats of the qualities of water and the methods of ascertaining them, in which the chemical and physical and biological properties of waters actually in use are discussed; methods of analyses are described; biological and bacteriological matters are investigated; and finally the relation of the quality of water to public health is discussed, particularly with reference to the conditions of France.

The third section treats of the improvement of the quality of water, its filtration and sterilization, and the various means for the purification of water used in England, France, Germany and the United States. The softening of water, the removal of iron, the removal of color, the removal of turbidity, and bacterial purification are considered, and sand filters, mechanical filters, sterilization of water by heat, sterilization by chemical methods such as sulphate of copper, ozone, etc., and finally the purification of water on a small scale in residences, are all described.

The fourth section deals with the quantities of water which must be supplied under various conditions of climate, habits of the people, and the size of plant which must be provided to meet these needs; of the collection and storage of surface waters and of keeping them in order for use, and the methods of computing the amounts which can be obtained; of underground waters, the possibilities of securing them, and the best way of doing it in different kinds of rock and gravel; and of the means of investigating underground supplies and finding where such supplies are obtainable. The question of natural filtration, or filter galleries, with which the authors seem to have had extended personal experience, is treated at length and is particularly interesting.

The fifth part treats of the transportation and elevation of water; of pumps and pumping stations; of aqueducts, pipes, etc. The theoretical examination of different types of pumps is different from and perhaps more complete than that to be found in any American text-book, and describes some of the most recent types of pumps, including stage centrifugal pumps and other impulse pumps, driven by electricity and by steam turbines, but one realizes from the descriptions that European practice in these lines is often very different from American.

The sixth part treats of the distribution of water; of pipes of various materials, and the way in which they are used; of reservoirs, their design, capacities, depths; of the use of open and covered reservoirs; of standpipes; of reinforced concrete towers, and of various accessories. The question of water waste is also investigated and methods of controlling it are described.

The seventh and shortest part treats of legislation, and relates principally to conditions of France.

The volume of plates, containing 72 double-page sheets, is in addition to the numerous illustrations contained in the text. These illustrations include drawings of many ancient aqueducts and water works structures; plates showing algae and bacterial growths in water; plans of many European and a few American water meters; plans of representative plants for the removal of iron, for the softening of water; and of a con-

siderable number of filter plants, including some arranged for double filtration, for preliminary filtration, and a number of mechanical filters and of works for the ozone treatment of water. A considerable number of plates relate to ground water supplies and methods of securing them; to deep well pumps, the underground flow of water, and allied subjects; and these include many devices used in Europe for securing ground water not thus far applied in the United States, and which will be of particular interest to American engineers. The maps and diagrams relating to the spring water sources of Vienna and Paris are of much interest. There are many plans of reservoirs in different parts of the world, including sections of high dams, steel-concrete dams, ornamental high-service tanks, reservoirs with two or more stories, used in some of the French cities. The examples of reinforced concrete reservoirs are particularly numerous and interesting.

In a number of respects the general treatment is novel and praiseworthy. The consideration of the whole subject of water supply is taken up systematically by topics, and a large amount of descriptive matter of water works all over the world is used in connection with this discussion. The practice of various cities is described in connection with each point. This has the disadvantage of separating the description of works so that it would be practically impossible to find all that is written regarding a particular water works system; but the object of the book is to instruct the reader regarding water works construction in general, rather than to describe particular systems, and the constant use of examples taken from actual practice is most helpful to a quick and full grasp of the subject.

The extensive use of projects in this illustrative way is a striking feature of the work. Projects are described and illustrated almost as freely as are works that have been built. This may reflect the present rapid development of the art in France, for it shows that the authors have many ideas which can be illustrated only by the aid of projects, as no works have yet been executed to serve as examples. No doubt when these works are executed many will differ considerably from the projects. This is certainly true in some American instances where the works since built, or now building, are quite different from those described by the authors.

The amount of detail in regard to many of the matters treated is surprisingly great to the American reader. Our reference books usually treat of general principles only. The engineer knows many things which he does not regard it necessary to reduce to writing, or for his non-professional employers to know; and in the same way the foreman knows a thousand things that he regards it unnecessary for the engineer to be fully informed about; and the art is to a very considerable extent made up of such matters which are not reduced to writing. Under American conditions this part of the art is, to a considerable extent, passed on from one person to another, as a new man learns the business from an older man with whom he works; and some parts of it are learned by the visiting of neighboring works by committees, engineers and superintendents, which is so common in America.

But in a work of the magnitude of that which the authors have undertaken it is possible to reduce to writing a great many of these minor points of the art, and this has been done. It has been done very unequally for the different sections, and this must necessarily be so. With some matters the authors are familiar from personal experience, and for these the minutest details have been recorded with a fullness which is at once a surprise and a pleasure; but other parts of the subject have been filled in from reading and study, and in these cases the descriptions are far more general.

Letters to the Editor.

WOOD PAVEMENTS.

SIR: We notice in your issue of May 26, page 661, a short article on wood pavements in New York. In this connection we think it may be of interest to you to see samples illustrating the behavior of the wood block pavement which has recently been laid on downtown streets in New York, and are, therefore, sending you, under separate cover, sections of a block originally laid, having a thickness of $3\frac{1}{2}$ in., and of a block taken from Chambers St. in April, 1906, which was laid there in December, 1904, and which has been under traffic, therefore, for only sixteen months. You will observe that the block has lost 0.2 in. in thickness, while the surface has been crushed and broomed out to an additional depth of 0.2 in. Under these circumstances, it would not appear that this form of pavement could be a very lasting one under the conditions to which it is exposed on heavy traffic business streets. Very truly yours,

NEW YORK TESTING LABORATORY,

By Clifford Richardson.

[The two samples of blocks accompanying the above letter show the reduction in depth mentioned by Mr. Richardson and also the brooming of the ends referred to. It is hardly fair, however, to judge a pavement from a single block, particularly as Chambers St. contains many manholes, valve boxes and other obstructions that cause pavement in their vicinity to deteriorate, with special rapidity.]

FIRE PROTECTION.

SIR: At the annual meeting of our association held here last week certain resolutions were adopted at the recommendation of the Executive Committee.

The officers and Executive Committee of this association judge it of especial importance that the attitude of the association as expressed in these resolutions should receive as wide dissemination as possible, and I, therefore, enclose copy herewith in the hopes that you will find space in your valued publication to include either the resolutions themselves or a suitable reference to them. Yours very truly,

Chicago, May 31.

W. H. MERRILL, JR.

[The resolutions read as follows:

Whereas, The National Fire Protection Association was formed ten years ago "to promote the science and improve the methods of fire protection; to obtain and circulate information on this subject and to secure the co-operation of its members in establishing proper safeguards against loss of life and property by fire," and,

Whereas, In spite of all efforts up to the present time the terrible fire waste of this country has continued uninterrupted involving a loss per capita several times greater than other countries, and,

Whereas, Public protection has not kept pace with the growth of buildings and increase of valuation in congested centers and as the business conditions and prosperity of the country are liable to interruption if this increasing loss cannot be checked,

Be it Resolved, by the National Fire Protection Association in convention assembled that an urgent appeal be and is hereby made to all interested to co-operate in bringing about better conditions by adopting improved methods of construction, by safeguarding hazards of occupancy and by introducing automatic sprinklers and other private protection with private water supplies quite in addition to the public fire service, and,

Be it further Resolved, That we recommend that municipalities pass ordinances involving the adoption of an approved building code along the lines of the building recommended by the National

Board of Fire Underwriters, and requiring the introduction of automatic sprinklers with private water supplies in buildings of special occupancy and in so-called congested districts, to the end that the danger of sweeping conflagrations may be largely eliminated.]

CEMENT BLOCKS FROM AN ARCHITECT'S STANDPOINT.

SIR: The writer has no intention of attacking concrete, cement stone or any similar building material, or in any way offering any hindrance to the development of a new product, artificial or natural. Nor is there any idea of defense of, or plea for any class of manufactured or natural article. This is intended solely as the expression of the opinion of one who, seeking the best material, has striven to use what he could find to the best advantage, and of one who has not feared to investigate a novelty if it has seemed to promise merit.

Cement concrete, taken in the usual sense of the words, meaning a composition of definite proportions of sand, gravel, broken stone or similar material with a hydraulic cement, the whole mixed with water and allowed to harden, is no novelty. Very ancient examples of some form of concrete construction still exist in excellent preservation. Experiments covering nearly all problems in the use of concrete, have given fairly definite data as to the strength, endurance, stability or the reverse, of all the various mixtures. We have used cement concrete, or beton, for foundations, footings, piers for walls, monuments, and even for beams to some extent; and believed we were using the best possible material. No question can arise as to the efficiency of concrete in these uses. It is eminently successful. Then why not blocks of concrete, of convenient size for handling, made under favorable conditions, and transported to the scene of their use? By favorable conditions is meant conditions favorable to the comfort of the workmen, which may or may not, be the best for the development of the efficiency of the material employed.

Once having decided upon blocks of cement stone, our attention is drawn to a lighter block made by tamping the concrete in moulds about removable cores, which forms a hollow block having the same appearance on the front and back faces, but saving weight and material. The position of the cement concrete block, whether solid or hollow, appears tenable to the casual survey, and the writer's attention was drawn to investigate its advantages or disadvantages, and there follow some of his objections.

Some years ago he had the good fortune to be in charge of a series of laboratory and practical tests of the products of a Western Portland cement company, and among other things he discovered that the greater percentage of moisture, consistent with the proper handling of the composition, produced the greater ultimate efficiency in the result. His experience with concrete hardened under water has been much more satisfactory than with that built in air, so far as density and hardness were concerned. This brings us to one serious objection to the present product of the cement block manufacturer, namely, the manner of production, hardening and transportation. The concrete blocks are made in portable moulds, into which the material is tamped, the mould immediately removed, and the block left to "cure" or harden under such atmospheric conditions as are obtainable. Sometimes they are set upon trucks and wheeled to a drying shed; sometimes the moulds are moved along, leaving the block to harden where made.

The concrete as mixed and used in the moulds is necessarily very dry, usually being dampened only enough to "pack," in order that the mould may be removed and the block still "stand up."

To overcome this deficiency in the composition, an atmosphere of excessive humidity is produced by artificial means, in which the block is left for a varying length of time. The setting of cement is the result of crystallization of the calcined silicates—a chemical reaction—and what is known as water of crystallization is absolutely necessary. Without a sufficient proportion of water perfect crystallization cannot result. Any excess of water is immaterial except as preventing the evaporation of the water of crystallization before the reaction is complete. Thus it appears that in the mode of manufacture the present system of concrete block production falls considerably short of developing the efficiency of the material used.

Concrete, properly mixed, dumped in place and well tamped is never moved, and is not intended to be moved. Portland cement after its initial setting continues to develop its strength for about four hundred days, perhaps longer, as the molecules gradually assume their permanent position. The usual procedure with manufactured blocks is to move them as soon as they are freed from the moulds, and after ten to fourteen days to load them upon wagons and haul them to the place where they are to be used. Added to the fault of insufficient water for proper crystallization of the cement, the jarring and jolting inevitable with the moving of the blocks is another occasion of weakness in the setting.

Looking through the advertising pages of certain contractors' and trade journals, one is struck by the immense number of designs, models and apparatus for cement block manufacture offered; and the keynote of it all is the small investment required to begin profitable operations. These advertisements are particularly successful in luring men of small experience and no judgment into a business that should require plenty of both. To use Portland cement with success and to obtain its maximum efficiency requires experience, skill and care, and none of these commodities are cheap in money value.

Cheap and unskilled labor, even with good direction, cannot be depended upon to produce uniformly satisfactory results; and when estimated in connection with mechanical means to the desired end, becomes a depressing factor.

The usual form of cement block is a rectangular unit 8 or 9 in. high; 18 to 32 in. long, and varying with the thickness of the wall desired. The side to be exposed when built into the wall is made either smooth or "rock-face," and a combination of several blocks of uniform appearance is monotonous in the extreme. The size of the unit is such that it is quite inflexible in composition, forestalling any possibility of variety except at the expense of special forms. To produce these require extraordinary designs in moulds, experiment by the manufacturer, and a high percentage of loss and failure. Immediately the advertised economy is lost, and the material has thereby no advantage over terra-cotta or stone.

For upwards of ten thousand years, men have been using blocks of natural or artificial stone to build their habitations, the size of the individual unit varying with the temporary exigency. In the modern standard brick, we have the consensus of opinion of all the ages, as to the proper size for a building unit. Sufficiently large to be a factor, small enough for flexible assemblage, and of convenient size for handling. Then why not cement brick? The same objections as to composition, handling and transportation will apply to cement brick as well as to larger blocks; and as to the smaller unit, we are led to ask, why cement brick? In conclusion, then, we find the cement block industry has failed to the present time, for three good reasons: First, the cement upon which the material depends for its composition is not properly used to obtain its greatest, and therefore economical, efficiency. Second, the production of cement blocks is being attempted

chiefly by inexperienced men, and with the sole idea of being done as cheaply as possible. Third, the size of the individual unit precludes any artistic use of the material compatible with the claims made for it.

Respectfully, VERE OLNEY WALLINGFORD.

COST OF GOVERNMENT DAMS IN THE WEST.

SIR: In your issue of May 12 appears a discussion of the cost of the work being done by the Reclamation Service. The writer has noticed the same article going the rounds of the newspapers. The country is to be congratulated on the promised low cost measured in units of "acre feet" or "million feet" of water to be stored for irrigation by the irrigation works now being intelligently designed and ably directed by the engineers of the Reclamation Service. But in as far as the article in question conveys to the public mind the impression that, in governmental execution of work, there is great and inherent economy generally, and in the Reclamation Service in particular, the comparisons made are misleading and likely to become odious.

To engineers familiar with the geological and topographical conditions under which the Croton and the Wachusett dams were built, and the radically dissimilar and extremely favorable conditions obtaining for the building of the Roosevelt, Shoshone and Pathfinder dams, the comparisons made are accepted at once at their true value. But laymen cannot do this so readily. The great dissimilarity in conditions, natural and commercial, the first in favor of, and the second adverse to, the Western dams, makes comparisons of relative costs useless, or worse, as any measure of the value of any great policy or of the efficiency of its propaganda. The able engineers of the Reclamation Service are doubtless willing to rest on the real merit of their work and must be adverse to having it presented to the public in a manner calculated to discredit the grand works of other eminent engineers. There is no danger of the article as appearing in your issue being misinterpreted by those who read it there; but this is not true of those who form conclusions under the glaring headlines of the Associated Press.

If comparisons are desired, there is, for the cases in question, a legitimate basis; viz.: the unit costs of work actually and necessarily done, including comparison of the nature and difficulty thereof. The relation of the quantity of masonry and its cost in a dam to the quantity of water impounded has absolutely no bearing on the question of the efficiency of the design and execution of the work. The facts that 350,000 cu. yd. of masonry across the narrow rock gorge at the lower end of the Tonto Basin where the Roosevelt Dam is building will, when done, impound 61,000,000,000 cu. ft. of water, as against 4,000,000,000 cu. ft. impounded by 833,000 cu. yd. of masonry in the Croton Dam, are matters for which God not man is responsible. Moreover, on the basis of unit costs per yard of masonry, the Croton Dam has the advantage at \$9 per yard as against \$11 for the Government dam. If, in addition, we consider that the size and depth of the foundations for the Croton Dam broke all records and that much the greater part of the masonry was laid therein beneath the surface of the earth, the comparison becomes even more favorable to it.

On the same basis, the Wachusett Dam cost \$7 per cu. yd., while the Government dams of Shoshone and Pathfinder are costing \$14 and \$19 respectively.

These higher costs for the Government work are the consequence of remote location in the arid West. There is no wizard in or out of the Reclamation Service able to change the conditions. Yours truly,

El Paso, Tex., May 26. J. L. CAMPBELL.